# Collier's Encyclopedia

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DE REVOLUTIONIBUS

*THE THEME OF THE END PAPERS OF THIS VOLUME IS MAN'S MARCH THROUGH HISTORY. THE PANELS REPRESENT WHAT, IN OUR EDITORS' OPINIONS, WERE THE CRITICAL POINTS OF HIS PROGRESS. THEY ARE ARRANGED CHRONOLOGICALLY FROM LEFT TO RIGHT.*

The pronunciation system used in *Collier's Encyclopedia* is based on the International Phonetic Alphabet.

## PRONUNCIATION KEY

(*alphabetically arranged*)

| *Phonetic Symbol* | *Sound Represented* | *Phonetic Symbol* | *Sound Represented* |
|---|---|---|---|
| ɑ | f*a*ther, c*a*r | ŋ | si*ng*ing |
| ɑ̃ | (Fr.) él*an*, *en* | o | n*o*te, *o*ld |
| ɒ | wh*a*t, n*o*t | õ | (Fr.) b*on*, r*om*pre |
| a | *a*sk, *a*nswer; (Fr.) *a*ttacher | ö | (Ger.) schön, böse |
| æ | h*a*t, b*a*ck | ɔ | *o*rb, *a*ll |
| æ̃ | (Fr.) v*in*, m*ain* | œ | (Fr.) l*eu*r; (Ger.) können |
| ai | cr*y*, sp*i*ne | œ̃ | (Fr.) br*un*, l*un*di |
| au | pr*ow*, l*ou*d | ɔi | t*oy*, p*oi*nt |
| b | *b*o*b* | p | *p*ro*p* |
| d | *d*i*d* | r | *r*oa*r* |
| e | f*a*te, *e*lite | s | *s*auce |
| ɛ | y*e*t, sp*e*ll | sh | ha*sh*i*sh* |
| ə | mak*e*r, *a*go | t | *t*ro*t* |
| ɜ | f*i*rst, b*u*rn | th | *th*irty-*th*ree |
| f | *f*orfeit | th | o*th*er *th*an *th*is |
| g | *g*a*g* | u | r*u*le, pr*u*ne |
| h | *h*ot*h*ouse | ü | (Fr.) cr*u*; (Ger.) gr*ü*n |
| i | *e*ve, benz*i*ne | ʊ | b*u*ll, b*u*sh |
| ɪ | *i*f, st*i*ng | ʌ | b*u*t, s*o*n |
| j | *j*u*dg*e | v | *v*i*v*id |
| k | *c*a*k*e | w | *w*oo*dw*ork |
| χ | (Ger.) i*ch*, a*ch* | y | *y*este*ry*ear |
| l | *l*oya*l* | z | priz*e*s |
| m | *m*i*m*e | zh | plea*s*ure, a*z*ure |
| n | *n*o*n*e | | |

This Pronunciation Key is designed for ready reference. A fuller explanation of the pronunciation system used in this encyclopedia will be found on the pages immediately preceding the text in volumes 1 through 19.

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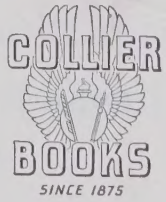


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# THE PRONUNCIATION SYSTEM

The system employed to indicate pronunciations in this encyclopedia is based on the alphabet of the International Phonetic Association. Inasmuch as the sounds that occur in the various languages of the world far exceed in number the letters of the English alphabet, any system designed to represent all these sounds must have recourse to a set of symbols that may or may not be closely related to the familiar alphabetical characters. The International Phonetic Alphabet has two notable advantages: it is widely known beyond the boundaries of any one nation, and it is readily applicable to all the languages of the world.

Certain modifications of the International Phonetic Alphabet have been considered desirable for the purposes of this encyclopedia. Thus, instead of the symbols *ʃ*, *ʒ*, *θ*, and *ð*, with which many readers are unacquainted, the more familiar combinations *sh*, *zh*, *th*, and *t͟h* have been employed. This modification violates the excellent principle that a single sound should be represented by a single character, but it makes the transcriptions easier for the ordinary reader to comprehend; wherever the letters that form these combinations are to be pronounced consecutively and separately, a raised period is set between them. A modification of opposite nature is introduced in the use of the single letter *j* to represent a combination of sounds which might also be transcribed *dʒ* or *dzh;* this modification, like the previous one, has been made for the purpose of simplifying the system for English readers. The consonantal sound *y,* for the same reason, is represented by the letter *y* rather than the letter *j*. In the table of vowel equivalents, the symbols *ö* and *ü* have been adopted from German for the rendering of certain vowels that occur in German and other languages but not in English, the assumption being that readers of foreign languages will generally find these symbols more illuminating than they would find alternative phonetic equivalents. In the use of the symbol *r,* no attempt has been made to distinguish between variations in the pronunciation of the sound that it represents; it is assumed that each reader will give to the symbol *r* precisely the pronunciation that he gives to the letter *r* in a written word. Furthermore, the single symbol *χ* has been used to represent not only the palatal voiceless fricative found, for example, in the German word *ich,* but also the velar voiceless fricative found in the German word *ach;* since, as a rule, the vowel that precedes the fricative automatically makes the sound that follows it either palatal or velar, it is unnecessary to indicate the distinction by phonetic symbols.

## TABLE OF EQUIVALENTS

### Consonants

| *Phonetic Symbol* | *Sound Represented* |
|---|---|
| b | *b*ob |
| d | *d*id |
| f | *f*orfeit |
| g | *g*ag |
| h | *h*ot*h*ouse |
| j | *j*u*dg*e |
| k | *c*a*k*e |
| l | *l*oval |
| m | *m*i*m*e |
| n | *n*o*n*e |
| p | *p*rop |
| r | *r*oar |
| s | *s*auce |
| sh | ha*sh*i*sh* |
| t | *t*rot |
| th | *th*irty-*th*ree |
| t͟h | o*th*er *th*an *th*is |
| v | *v*i*v*id |
| w | *w*ood*w*ork |
| y | *y*esteryear |
| z | pri*z*es |
| zh | plea*s*ure, a*z*ure |
| ŋ | si*ng*i*ng* |
| χ | (Ger.) i*ch*, a*ch* |

# THE PRONUNCIATION SYSTEM

## Vowels

| *Phonetic Symbol* | *Sound Represented* |
|---|---|
| ɑ | f*a*ther, c*a*r |
| ɑ̃ | (Fr.) él*an*, *en* |
| ɒ | wh*a*t, n*o*t |
| a | *a*sk, *a*nswer; (Fr.) *a*ttacher |
| æ | h*a*t, b*a*ck |
| æ̃ | (Fr.) v*in*, m*ain* |
| e | f*a*te, *e*lite |
| ɛ | y*e*t, sp*e*ll |
| ə | mak*e*r, *a*go |
| ɜ | f*i*rst, b*u*rn |
| i | *e*ve, benz*i*ne |
| ɪ | *i*f, st*i*ng |
| o | n*o*te, *o*ld |
| õ | (Fr.) b*on*, r*om*pre |
| ö | (Ger.) schön, böse |
| ɔ | *o*rb, *a*ll |
| œ | (Fr.) l*eu*r; (Ger.) können |
| œ̃ | (Fr.) br*un*, l*un*di |
| u | r*u*le, pr*u*ne |
| ü | (Fr.) cr*u*; (Ger.) grün |
| ʊ | b*u*ll, b*u*sh |
| ʌ | b*u*t, s*o*n |

## Diphthongs

| | |
|---|---|
| ai | cr*y*, sp*i*ne |
| au | pr*ow*, l*ou*d |
| ɔi | t*oy*, p*oi*nt |

The tilde (˜), wherever used, indicates that the vowel above which it appears is nasalized.

In the application of this system in the encyclopedia, indications of pronunciation are restricted to article heads, particularly to those that may be supposed to present difficulties in pronunciation. In these cases the phonetic symbols are printed in square brackets following the head, and stresses are indicated by accents placed immediately after stressed vowels, a heavy or a light accent indicating respectively a primary or a secondary stress. When more than one pronunciation of a given word is in wide use, the variations appear in the phonetic transcription.

The phonetic symbols are intended to serve as a flexible guide to pronunciation, not as a standard of correct usage. Usage varies so greatly in the English language between different groups of society, between different localities, and between different nations speaking the same language, that the selection of a norm is, for the purposes of an encyclopedia, practically out of the question. Users of the encyclopedia may find distinctions in pronunciation which they do not themselves observe in their ordinary speech, but in such cases the system of transcription is sufficiently flexible to admit variations. For example, many speakers, especially in the United States, pronounce the vowel in *what* virtually as they pronounce the *a* in father; the encyclopedia's symbol for the vowel in *what* is ɒ, but when these speakers encounter that symbol in a phonetic transcription, they will presumably give it approximately the value of the symbol ɑ wherever it occurs.

# COLLIER'S ENCYCLOPEDIA

# VOLUME EIGHTEEN

## SODALITE to TZU HSI

**SODALITE** [so′dəlait], a feldspathoid mineral containing sodium aluminum silicate with chlorine, $Na_4Al_3Si_3O_{12}Cl$. It may have a deep blue color. Sodalite tends to crystallize in the twelve-faced spheroidal dodecahedron. It also has poor dodecahedral cleavage (six directions). The environment for sodalite is the same as for another feldspathoid, nepheline, with which it is often associated. The precipitating magma must have been relatively low in silica. Massive blue sodalite occurs in Quebec, Ontario, and British Columbia. K. K. L.

**SODA NITER,** a mineral named after a chemical compound, $NaNO_3$. It ordinarily occurs in masses or as an incrustation. Soda niter is soluble, with a characteristic cooling taste. It is found only in regions of exceptional acidity. The outstanding deposits are in northern Chile, where the mixture of soda niter, salt, gypsum, and silt is called caliche. The origin of the Chilean caliche is in dispute. It is vigorously exploited for the manufacture of nitrate fertilizers. Soda niter is also used in making explosives. K. K. L.

**SODDY, FREDERICK** [sɒ′di] (1877- ), English chemist, was born at Eastbourne, Sussex, Sept. 2, 1877. He is noted for his work on the rate at which radioactive substances disintegrate, and the origin and nature of isotopes. Educated at Eastbourne College, the University College of Wales, and Merton College, Oxford, Soddy became demonstrator in chemistry at McGill University, Montreal, undertaking research on radioactivity with Lord Rutherford there in 1900, then with Sir William Ramsay at the University College, London, in 1903, as a lecturer at Glasgow from 1904 to 1914, as professor of chemistry at Aberdeen from 1914 to 1919, and finally as Lee's professor of inorganic and physical chemistry at Oxford from 1919 to 1936, when he retired. Soddy originated the disintegration and displacement laws of radioactive elements, which led to his discovery of isotopes, which he named and first described in 1912. He was also a protagonist of the virtual wealth theory of money, and of the application of laws of conservation to economics, writing several monographs on the subject. He was president of the Roentgen Society in 1905, was elected Fellow of the Royal Society in 1910, and was awarded the Nobel Prize in chemistry for 1921. H. N. A.

*FREDERICK SODDY*

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**SÖDERBERG, HJALMAR** [sö′dərbæry] (1869-1941), Swedish author, was born in Stockholm on July 2, 1869. After completing his education he spent some time as a journalist in southern Sweden, but he soon returned to Stockholm and from 1895 onward devoted himself to creative writing. He has often been called the typical Stockholm writer, but for many years he made his home in Copenhagen, where he died on Oct. 14, 1941.

Söderberg was influenced at first by Herman Bang, later by Guy de Maupassant and especially Anatole France, who seems to have helped him find his own style. He was strongly opposed to the literary movement represented by Verner von Heidenstam and was closer to August Strindberg, whose work he tried in some degree to carry on. Söderberg, however, was never the leader of a literary school; he always stood alone. As a matter of style, he ranks among the foremost in Swedish literature. Ironical, skeptical, and resigned, he is a typical representative of the *fin de siècle* mood in its Swedish aspect.

Söderberg's literary production consists of only a few volumes. He wrote four novels, of which *Martin Bircks ungdom* (1901), English translation *Martin Birck's Youth* (1930), is best known; a few collections of short stories, some of them translated in *Selected Short Stories* (1935); and three plays, among them *Gertrud* (1906). Throughout his life he was interested in theology and the history of religion, but his writings on these subjects were not seriously received by scholars. In *Sista boken* ("The Last Book"), a miscellany published posthumously in 1942, he pointed out the danger to modern civilization that was posed by the rise of Nazism in Germany. A. Wi.

**SÖDERGRAN, EDITH** [sö′dərgran] (1892-1923), Swedish-speaking Finnish poet, was born in St. Petersburg (now Leningrad), Apr. 4, 1892, and lived in Raivola, in what is now Karelia. In 1916 she published her first collection, *Dikter* ("Poems"), which showed her strong temperament and her rich visionary fancy. More difficult are her later lyrics, such as those published in *Landet som icke ar* (1925)

("The Land Which Does Not Exist"). Here she tried to carry out the program of Expressionism, to make poetry a spontaneous expression of the emotions, without the control of the intellect. She wrote some of her best poems, which were typically hymns about the beauty of life or visions of the blessings of eternity, while suffering from an incurable illness. Her work has been of great importance in the literary development of Finland as well as Sweden, and she has influenced an entire school of later Scandinavian poets. She died on June 24, 1923. A selection of her lyrics, *Min Lyra* (1929) ("My Lyre"), was published after her death.

A. Wi.

**SODIUM** [so′diəm], symbol Na (Latin *natrium*), atomic number 11, at. wt. 22.997, density 0.971, m.p. 97.5° C., b.p. 880° C. Sodium was first prepared by Humphry Davy, in 1807, by the electrolysis of sodium hydroxide, and it is still made that way. Attempts to manufacture it by the electrolysis of fused chloride have met with failure because of the destruction of the electrodes. Sodium is widely distributed as common salt, sodium chloride, NaCl. Beds in Germany have reached a depth of 4,000 ft.; in New York, 75 ft.; and in Michigan, 400 ft. Deposits in Poland are said to be 50 mi. long, 20 mi. broad, and 1,200 ft. thick. It is estimated that the oceans contain enough salt to cover the earth's land surface to a depth of 400 ft. Sodium is abundant also in Chile saltpeter, $NaNo_3$, and in mineral silicates, borates, carbonates, and sulphates. It constitutes 2.5 per cent of the earth's crust.

**Properties.** Sodium is the third member of Group I-A of the periodic table. It is the second member of the alkali metal group, which includes lithium, sodium, potassium, rubidium, cesium, and francium. These metals have one electron in a large outer orbit; this property results in a metal which is soft, light in weight, malleable, low melting, and very active chemically. Sodium is one of the most active of all metals and therefore displaces most of them. For example, it reacts with aluminum chloride to produce aluminum. H. Y. Castner's researches on this method in 1880 for its industrial possibilities led him to discover a cheap method for producing sodium in abundance. Sodium reacts with oxygen of the air to form the peroxide $Na_2O_2$. A piece of sodium is ordinarily coated with a white oxide, $Na_2O_2$, which on being scraped away reveals a silvery luster. The oxide $Na_2O$ dissolves in water to form sodium hydroxide. Thrown upon water, sodium liberates hydrogen. The heat of reaction is not as great as with potassium, so that the hydrogen is not likely to ignite spontaneously unless the piece of sodium is large. Sodium is an excellent conductor of electricity and is processed into wire for carrying 4,000-ampere current, where light weight is desirable. Sodium is so malleable and ductile that it may be drawn out into wire. The organic chemist has sodium presses about the laboratory to prepare sodium wire for removing water from his organic chemicals. Sodium amalgam formed with mercury is less active than sodium, alone. The amalgam with potassium contains 24 per cent sodium and 76 per cent potassium. Sodium forms a hydride, NaH, which reacts with CO to form sodium formate, HCOONa. The solubility of sodium chloride changes little with temperature; 26.3 per cent at 0° C. and 28.1 per cent at 100° C. *See also* Alkali Industry; Salts.

H. N. A.

**SODOM** [sɒ′dəm]. Sodom and Gomorrah, Admah, Zeboiim, and Zoar were the five Cities of the Plain, which were notorious for their wickedness, according to the Book of Genesis. In his wrath the Lord destroyed the first four with a hail of "brimstone and fire," but Zoar was spared and served as a place of temporary refuge for Lot and his two daughters, Lot's wife having been turned into a "pillar of salt." In several passages in both the Old and New Testaments the fate of Sodom and Gomorrah is recalled as a warning of what the Lord has done in the past and can do in the future to punish the wrongdoer. Yet both the location and manner of destruction of these Cities of the Plain have remained a mystery.

The Biblical evidence points to a location at the southern end of the Jordan River-Dead Sea Valley, in a mountain-hemmed region that is nearly 1300 feet below sea level. Lot, having selected the fertile Jordan Valley, pitched his tents as far as Sodom. The four Eastern Kings, who twice invaded and raided the Cities of the Plain, fought with the five kings in the "vale of Siddim," which was full of wells of asphalt ("slime pits" in the older translations). Both ancient and modern writers attest the presence of asphalt (Greek) or bitumen (Latin) around the Dead Sea, especially around the southern part. Josephus, writing in Greek, calls the Salt Sea (the modern Dead Sea), "Lake Asphaltitis."

At the southwest corner of the Dead Sea rises a low mountain made up in part of compact crystalline salt, which the Arabs today call Jebel Usdum, the Mount of Sodom. This salt mass, a hundred feet in height, is continually being eroded and creviced, and thus are formed pinnacles of salt that simulate a human figure. Biblical and Mohammedan traditions, ancient and modern travelers, have associated such formations with Lot's wife. So pecularities of the Mount of Sodom suggest that Sodom was located near the southern end of the Dead Sea, a region that is quite lush with vegetation, especially where five streams empty into the southeast part of the Dead Sea and where there is irrigation.

Archaeological evidence also supports the locating of Sodom and the other Cities of the Plain in this region. A pilgrimage place, Bab ed-Dra, has been discovered east and above the southern part of the Dead Sea, which appears to have been periodically frequented during the period about 2300 and 1900 B.C., to judge by the pottery found at the site. But no settlements have been found which furnished the attendants at the festivals at Bab ed-Dra, and yet they must have been situated near by. There remains only one place in which to locate the ill-fated Cities of the Plain—under the present waters of the southern embayment of the Dead Sea. Here, south of the peninsula el-Lisan ("The Tongue"), the maximal depth of the water is less than twenty feet whereas north of the peninsula soundings have recorded depths of over 1100 feet. This area was at one time a fertile plain, called the Valley of Siddim. Obviously the water level of the Dead Sea has been rising, and records taken over a period of years indicate an average rise of from 2½ to 3½ inches a year. Striking proof of this phenomenon is the presence of dead trees now a mile out from shore in the heavily concentrated salt water at the southern end of the Dead Sea. And now the parenthetical notation in Genesis 14:3 becomes clear: "the vale of Siddim (which is the Salt Sea)," in other words, which is now under the Salt Sea.

The destruction of Sodom and Gomorrah was brought about by the Lord after Abraham had failed to find even ten righteous men in all of Sodom. According to Genesis 19:24-28, the Lord rained "brimstone and fire" upon the Cities of the Plain. Recent investigations, conducted by geologists for certain oil companies, have revealed the presence of petroleum in the region around Jebel Usdum, as well as seepages of asphalt. The foul odors and the imperceptible soot which, according to ancient writers, arose from the Dead Sea and tarnished metals, may be explained as natural gas, the nature

of which was, of course, unknown to the ancients. Thus a possible explanation of the destruction is that oil and the accompanying emanations of gas may have been ignited by lightning, or an earthquake, so common in this region, may have overturned hearth-fires, and a great conflagration resulted. It is to be noted that Abraham, from a place near Hebron, saw smoke rising from the Plain, which went up "as smoke of a furnace," a description applicable to the burning of oil and gas. The abandonment of the pilgrimage site, about 1900 B.C., may therefore date the destruction of Sodom and Gomorrah about the end of the twentieth century B.C. J. P. H.

**SOEMBA, SUMBA,** or **SANDALWOOD** [su′mbə], an island in the Indian Ocean, southwest of Flores Island, from which it is separated by Soemba Strait. It belongs to the Lesser Sunda Islands, east of Java, and it has many bays and good anchorage along the coast. Soemba lies southeast of Sumbawa and southwest of Flores, about 38 mi. from each. It is 140 mi. long from northwest to southeast and 24 to 50 mi. in width. It rises abruptly from the sea and has only the narrowest of coastal plains. Differing from the islands that lie just to the north, it is sedimentary, and not volcanic, in formation. For the most part, it is a plateau about 2,000 ft. in elevation, with a few peaks rising higher, though none exceed 4,000 ft.

Soemba's alternate name is Sandalwood Island, but the sandalwood trees are now gone from the coastal sections. There are, however, many still growing in the interior. Forests are present but are far less dense than those of the islands farther west; for while Soemba has a fair amount of rain, there are times during the year when very little falls, and in the month of July there is usually none. The main occupation of the population is agriculture and cattle-breeding, and the horses of Soemba Island are renowned throughout the archipelago. The art of weaving is highly developed by the residents. The town of Waingapoe, which is on an inlet on the northern coast, is the headquarters of an assistant resident. Waikalo is a village on the northwest coast. From both these towns the island exports the sturdy little horses for which Soemba is well known. Maize, a little rice, sago, tobacco, indigo, and a small amount of cotton are grown.

Formerly the island was a slave-trading center. The island was first mentioned by Antonio Pigafetta in 1522, and was given the name of Sandalwood Island in 1663 because of the sandalwood trees which then covered it. The Dutch East India Company maintained a functionary on the island, which came under the residency of Timor in 1820. Direct control was assumed by the Netherlands in 1866. In 1946, Soemba became part of the State of East Indonesia, one of the former constituents of the United States of Indonesia, all of which ceased to exist on Aug. 17, 1950, when they became a part of the independent Republic of Indonesia. R. G. B.

**SOEMBAWA** or **SUMBAWA** [sumbɑ′wə], one of the Lesser Sunda Islands east of Java in the Republic of Indonesia at 8° 30′ S. lat. and 118° E. long. Soembawa lies between the island of Lombok on the west and the Flores Sea on the northeast. The island, about 175 mi. long and 55 mi. across at its widest point, has a quite irregular coast line and one of the best harbors in the republic at Bima Bay on the northeastern coast. Although mountainous, the soil is fertile and suitable for producing tropical crops. Horse and cattle raising are important occupations. Raba, the chief town, is located on Bima Bay, and the highest point of the island is Mt. Tambora, at the tip of the northern peninsula, which is now 9,354 ft. in height but was, until 1815, about 13,000 ft. in elevation. A volcanic eruption in that year reduced the peak. R. G. B.

**SOERABAJA** or **SURABAYA** [sʊrəbɑ′yə], the second-ranking trade center and principal naval base of the Republic of Indonesia, situated in Java on the Mas River and on the narrow strait between Java and Madoera or Madura Island, 400 mi. northeast of Jogjakarta or Djokjakarta. The harbor and naval base, whose entrance is guarded by fortresses on the island of Madoera, offer every facility to warships, up to and including cruisers. Railroads and excellent highways link Soerabaja with all of Java and airlines connect it with the principal cities on the island as well as with other terminals in the archipelago. The population is estimated at 600,000.

Chief industrial establishments are tool factories, shipping yards, and metal works. Main exports are sugar, coffee, tobacco, maize, tapioca, and hides. B. L.

**SOERAKARTA, SURAKARTA,** or **SOLO** [sʊrəkɑ′rtə, so′lo], a town in south central Java in the Republic of Indonesia, situated on the Solo River, 35 mi. east of Jogjakarta. Soerakarta has railroad connections with Jakarta (Batavia), Semarang, and Soerabaja. The population is estimated at 170,200. It is the seat of the Susuhunan (Prince) of Soerakarta, whose palace, called the Kraton, occupies a large part of the town and has more than 10,000 people living within its walls. A large mosque and many smaller ones are situated there.

Soerakarta has many native industries including goldsmithing, saddle-making, and the painting of the famed Solo batiks. The main products of this region are rice, indigo, coffee, sugar, tobacco, cocoa, and kapok. B. L.

**SOFIA** or **SOFIYA** [so′fiə, sofi′ə; sɔ′fɪyɑ], capital of the "people's republic" of Bulgaria and of the county of Sofia, located in west central Bulgaria on a mountain-enclosed plain at about 1,700 ft. elevation. The Bogana River, a tributary of the Golem Isker, passes northward through the city. Sofia is the most centrally located of all cities in the Balkans, with easy passes in all directions from its mountain-rimmed location. Sofia's climate is, on the whole, agreeable. Highest temperatures may reach 100° F. in summer but nights are generally cool, and the mercury in winter often drops below

*The National Opera at Sofia, Bulgaria, one of the capital's most impressive buildings*

BURTON HOLMES FROM EWING GALLOWAY

zero. Yearly rainfall averages less than 30 in., winter being the driest period.

The site of modern Sofia has long been occupied by towns of varying importance. A city founded there about A.D. 100 by Trajan was known as Serdica and served as an administrative center. Huns burned the town in A.D. 447; its successor was captured in 809 by Bulgars under Tsar Krum. Coming under control of the Byzantine Empire in 1018, the town was renamed Triaditza and served as an outpost city of the Empire for the next 168 years. The Turks took it in 1382 and held it, with the exception of brief occupations by Hungarians in 1443 and Russians in 1829, until 1878. The city became the capital of the Bulgarian principality in 1878 when the Russians freed the Bulgars from the Turks.

The most important industrial city in Bulgaria, Sofia is a sugar-refining center and has a number of metal-products industries and silk, cotton, and woolen mills. In addition it has vegetable-oil extraction industries, breweries, rubber industries, factories making soap, tobacco products, brick and tile, and leather tanneries. It is one of Bulgaria's major rail cen-

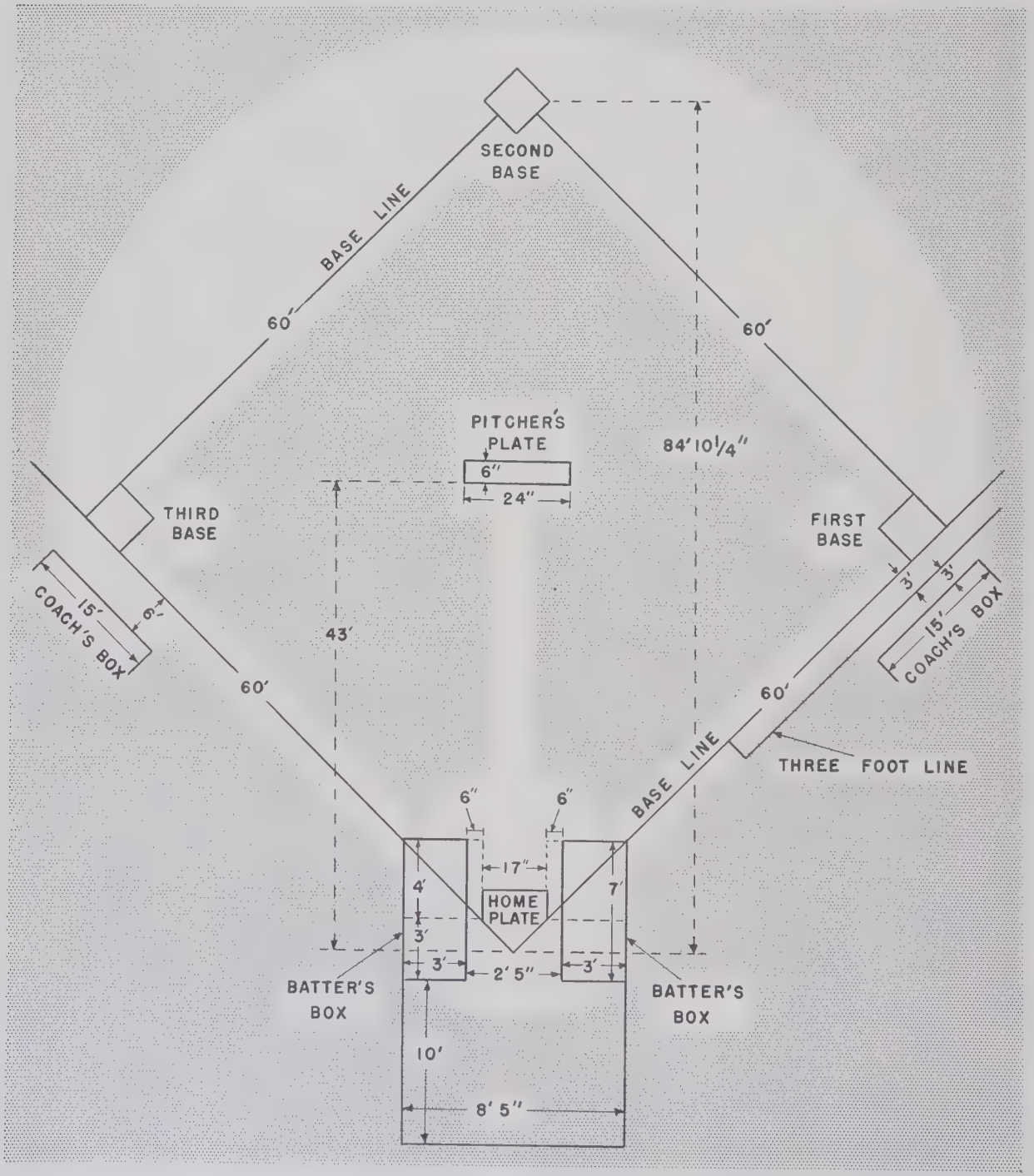



*DIAGRAM OF A SOFTBALL DIAMOND*

ters, and the railway from Paris to Constantinople passes through Sofia. North and south lines provide connections with Romanian and Greek railways by way of the Isker and Struma river valleys. Pop. 1946, 366,925. E. St.

**SOFTBALL,** a form of baseball, an outgrowth of attempts to play baseball indoors. Because of the limited area in indoor arenas, smaller playing fields were laid out. Because of the closer proximity of the players a softer, slower ball was devised. A smaller, lighter bat followed. Finally, because the shorter distance between the pitcher and the batter gave the pitcher too great an advantage, the pitcher was required to throw underhand to the batter. These are still the principal differences between softball and baseball.

The game, called "indoor baseball" at first, made slow progress towards popularity until the late 1920's when it became widely known in Canada. During the early 1930's it was introduced on playgrounds and recreational fields in the United States, and became extremely popular. Played at first principally by children, it was soon adopted by men who found its smaller proportions ideally suited to the limited playing areas available in cities and large towns. The fact that it could be played capably by relatively unskilled players, who would not be able to play baseball with the finesse and co-ordination that that sport demands, added to the game's popularity. Softball, played by practiced athletes, however, can be a fast, skillful game. Despite early efforts to standardize the rules, local practices prevailed, and by 1933, when the first national softball championships were held, it was discovered that the rules varied in almost every section of the country. Official rules were established but have been changed frequently, and discrepancies still exist between various codes. Softball rules are generally similar to baseball rules, with the major exceptions having to do with the size of the field (*see accompanying diagram*), the size and composition of the ball, the size of the bat, the restrictions that are placed on the base runner, and the requirement that the pitcher deliver the ball to the batter with an underhand motion.

National tournaments are sponsored each year by the American Softball Association and the National Softball Congress. *See also* BASEBALL. R. W. Cr.

**SOFT-SHELLED TURTLE,** broadly, any member of the Trionychoidea, one of the three suborders of Testudinata. This turtle is usually pancake-like in form and has a pliable "shell" covered with leathery skin and a soft, tubular snout. The family Carettochelydidae includes only the peculiar pitted-shell turtle, *Carettochelys insculpta,* of New Guinea, the only fresh-water turtle with flippers. The ancient family Trionychidae includes seven living genera, many species of which occur in Asia, Africa, and North America. These species have fleshy lips hiding sharp jaws, and heads that may be retracted readily by bending the neck vertically. The spiny soft-shell *Amyda spinifera* of eastern United States inhabits unpolluted waters, and lays one to two dozen spherical, hard-shelled eggs. It measures 15 in. in shell length, and is eagerly sought as food. M. G. N.

**SOGNEFJORD** [sɔ′ŋəfyor], the longest of the Norwegian fiords, located in western Norway, 50 mi. north of Bergen. It extends eastward from the Atlantic for 136 mi. far into the plateau of southern Norway. From this plateau and the Jotunheimen Mountains to the north, the Sogne receives considerable amounts of water, much of which descends in high falls from the upland surfaces. The mountainous sides of the fiord rise to 5,000 ft., often as precipitous cliffs. Many of the tributary fiords lie so deep that they receive sunlight not at all in the winter and only for a few hours during the summer days. The Sogne averages 3¾ mi. in width but in the tributary fiords often narrows to less than 600 ft. Its waters are deep for most of its length, exceeding 4,500 ft. in some sections. As this tremendous trough cut by the glacier nears the ocean, it becomes much shallowed, until at the coast a rock threshold with shallow water separates the two. The major tributary fiords to the south are the spectacular Naeröfjord, Åurlandsfjord, and Laerdalsfjord, those to the north are the Fjaerlandsfjorden, Sogndalsfjord, Lusterfjord, and Årdalsfjord. The important towns of the Sognefjord are the aluminum center of Höyanger, the resort at Balestrand, and the manufacturing town of Laerdalo. Because of its salt water and great depth, the Sognefjord does not freeze in winter, thus providing a superb year-round artery of travel for the region. Roads parallel the shore for parts of its length, but fiord boats provide the major means of transportation. The wild grandeur of the Sognefjord has made it a favorite with European and American tourists. J. E. V.

**SOHR, MARTIN.** *See* AGRICOLA, MARTIN.

**SOHRAB AND RUSTUM** [sorɑ′b, rʌ′stəm], a narrative poem by Matthew Arnold, published in 1853. It presents, as an episode in Homeric style, a part of the Persian legend of the hero Rustum. Rustum's wife had borne a son, Sohrab, but to keep him with her as long as possible she reported that the child was a girl. Rustum has been traveling in distant countries, finding glory in war. Sohrab, now a young man and a prodigy in warfare, seeks to make himself known worthily to his father and challenges an enemy army to send a single champion against him. Rustum accepts the challenge in disguise, and mortally wounds Sohrab, from whose dying words he learns that his child is a son and that he has killed him. W. D. T.

**SOIL.** Wherever plants grow, soil covers the land. It is a patchwork blanket, varying from place to place. Soil includes many thousands of soil types, just as vegetation includes many kinds of plants. On very young lands, in the high mountains, or near the poles, soils are scarcely more than thin films. Under the tropical rain forest, they may be 10 ft. deep or more. In the United States, useful soils are generally 2 to 5 ft. deep.

Solid rock often lies hundreds of feet beneath the surface, under mixtures of stones, gravel, sand, silt, and clay. But this loose mixture is not soil. Only the surface layers, in which plants have their roots, and in which small animals and micro-organisms live, constitute the soil.

Soils have area as well as depth. Each natural kind of soil is the product of a particular combination of 5 factors: (1) climate, (2) living matter, (3) parent rock, (4) relief, and (5) time. The upper surface of a soil may be nearly flat, or undulating, or hilly. Its bottom is defined by the limit of influences of plant roots and other forces that have changed the loose rock material to soil. The sides of a soil are its boundaries with other soils, where one or more of the five genetic factors change.

Thus, soils are solid pieces of landscape. All the pieces that are alike, wherever they are found in the world, belong to one soil type. These are not scattered about at random, but in an orderly, discoverable pattern. Then, too, soils are dynamic, changing with the rising and sinking of the land;

with the gradual washing away of the surface and the sinking of the soil into fresh material; with the accumulation of ash, dust, or silt on the surface; with changes in plants and animals; and with the long passage of time.

Such natural soils are used by farmers, gardeners, and foresters for production. The farmer makes his arable soil from the natural soil. He may improve its physical structure and fertility a great deal; he may use up its nutrients and allow it to become unproductive, or even to waste away.

## SOIL MORPHOLOGY

If a trench, or pit, is made in a soil down to the unaltered rock material beneath, its characteristics may be studied.

**Soil Profile.** The soil, in the first place, is made up of layers, called horizons. Some or all of these horizons may be thin, scarcely an inch thick; or they may be several inches thick. Sometimes the lines between them are sharp; often one horizon gradually merges into one above or beneath. Each has its own physical and chemical characteristics. These horizons, taken together, are called the soil profile. By studying the profile of many soils, scientists arrange them into a system of classification. Through scientific correlation, a new or unknown soil may be placed in the system.

**Soil Texture.** The relative proportion of particles of various sizes that make up a mass of soil determines soil texture. The individual size-groups, or "separates," range from gravel, the coarsest, through sand and silt to clay, the finest. Clay is by far the most important size-group, since it has the largest amount of surface exposed for physical and chemical actions. The particles in one pound of dry clay have a total surface of about one acre.

Actual soil horizons consist of mixtures of particle sizes. The words used to name their texture, beginning with those having the most clay, are: clay, clay loam and silty clay loam, silt loam, loam, sandy loam and fine sandy loam, loamy sand, and sand. The terms gravelly, cobbly, and stony may be used to modify these names if large amounts of gravel, cobbles, or stones are present.

Soils very rich in gravel and sand hold little water between rains. Clay soils are commonly sticky when wet, and hard when dry. Loam soils having a fair mixture of sand, silt, and clay are most likely to hold water without retaining too much. But the effect of the clay depends on its chemical composition. Soils of equal clay content vary widely in stickiness and hardness.

Then, too, the texture of the several horizons in the soil profile may (or may not) vary greatly. In other words, three soils may have sandy-loam surface horizons: one may be underlain by coarse gravel, another by loam, and a third by tight, heavy clay. Other things being equal, the first will be too dry for general cultivation, the second about right, and the third too wet, at least during rainy periods.

**Soil Structure.** The grouping of the soil particles into plates, blocks, or granules determines soil structure. At the extremes are structureless soils: those consisting of separate grains, as in sand dunes, and massive clays or hardpans having no regular breakage. A granular structure is best for crop plants; the aim of the farmer must be to produce and maintain such a structure.

**Color.** The color of the horizons tells about the soil's chemical and mineralogical composition. Soils rich in organic matter are black or very dark brown in temperate regions, and dark brown in the tropics. Iron-rich soils are commonly red, although they may be yellow or even gray if they are wet, or have been wet recently. Nearly white soils are thoroughly leached or unusually rich in salts.

**Chemical Composition.** The appearance of the various horizons does not suffice to determine their chemical composition. Acidity can be determined in the field by simple tests. With field tests and experienced observations of color, some compounds may be estimated, but for accurate data, samples of the horizons must be taken into the laboratory.

The larger part of most soil horizons is made up of insoluble compounds of silicon with aluminum, oxygen, hydrogen, iron, calcium, magnesium, and potassium. Yet most of the other 90-odd elements are present, at least in tiny amounts. The relatively insoluble compounds yield, directly, few or no nutrients to plants, but they are extremely important in holding or releasing soluble compounds that do influence plants.

Normal plants must obtain from the soil many nutrients in proper balance including nitrogen, phosphorus, potassium, calcium, magnesium, sulphur, iron, zinc, copper, boron, manganese, and molybdenum. The first six are most commonly lacking in the soil. The last six are needed only in very tiny amounts. The lack of any one of them may limit plant growth, and all are now used in fertilizers.

Soils vary in the total amounts and in the availability to plants of each of these nutrients. Since plants vary a great deal in what they need, a luxuriant native vegetation does not necessarily indicate the presence of abundant nutrients for crop plants, which may have different requirements. This fact is significant since native plants leave their remains in the soil for new plants to use, whereas a farmer may remove the crops, and with them a part of the nutrients.

**Organic Matter.** A great storehouse of plant nutrients is the soil's organic matter. Of first importance is the living matter itself: the trees, grasses, roots, and animals. After this material dies, micro-organisms in the soil decompose it, releasing the nutrients they contained to be absorbed by new plants. A small part of the product of decomposition is a dark-colored, relatively stable material called humus.

## THE GREAT SOIL GROUPS

Soil phases, types, and series are grouped into families, and these families, in turn, into great soil groups. Some 40 to 50 great soil groups are recognized, but some are not well defined, and a few others may be established following further research in the tropics and the subarctic.

There are three great soil groups: zonal, intrazonal, and azonal. The zonal groups, or continental soil types, are those upon which the climate and vegetation have made their full, or nearly full, impress, without local disturbances from extremes of slope or of parent rock. These soils are found on well-drained uplands, nearly level to rolling, over parent materials of mixed physical and chemical composition. The zonal groups dominate the soils of a broad area.

Intrazonal soils also have characteristics that reflect some influence of climate and vegetation; but these soils are principally dominated by some local factor, such as poor drainage or very limy parent material. The bog soil found in swamps is an example of such an intrazonal soil.

The azonal soils have no developed features, since their parent materials have been formed, and may be found associated with any of the other great soil groups. By far the most important azonal group comprises the alluvial soils of the young flood plains and deltas, in which soil-forming processes have not had time to modify the recently deposited parent material.

A general view of the soils of the world can best be had by looking at the five principal zonal groups: the tundra, the podzol, the chernozem, the desert soils, and the latosol.

**Tundra.** Generally, these soils have dark-brown, peaty layers over gray, moist soil. Most are ever-frozen a foot or two beneath the surface. Little use is made of them. In the same region are many bog soils and lithosols. Everywhere in high mountains about the timberline, there are somewhat similar soils, often referred to as "alpine meadow" soils which support vegetation for summer grazing.

**Podzol.** In the cool, humid, forested regions there are light-colored, leached, acid soils. There is a surface covering of raw organic matter, but not much humus. By using lime and fertilizers, and by growing legumes and grasses part of the time, such soils can be made productive. Podzols are much cultivated in northern Europe and in part of North America. Further development of industry and of transportation will make more of them useful, especially for the cultivation of vegetables and for dairying.

Just south of the podzols, in the Northern Hemisphere, are the gray-brown podzolic soils. They are light-colored and leached. They are even more responsive to good management than the podzols, and can be used for a wide variety of crops.

**Chernozem.** These black soils have developed in subhumid temperate regions under tall grasses. They are well granulated and fertile. Most of them are in the interior of continents. They furnish the larger part of the bread grains for the world. Their uncertain climate limits crop production, both as to yield and kinds of crops.

Between the chernozem and the gray-brown podzolic soils are the prairie soils, also developed under grasses, but having more rainfall. Prairie soils are dark-colored and fertile. The only large area of them lies in the American Midwest, centering in Iowa. These soils are most productive of corn and other grains, usually when just plowed.

In passing from the chernozem to the desert, the soils become dark brown (chestnut), brown, and, finally, gray (sierozem). All have a layer of accumulated calcium carbonate (lime) underneath, usually two to four ft. deep and nearer the surface as it approaches the desert. Chestnut soil, and the very best of the brown soils, can be used for grains, although irrigation is often required.

In passing from the chernozem toward the tropics, the soils become more red (reddish chestnut) and merge with the latosol.

**Desert Soils.** Some authorities hold that true deserts have no plants at all, but desert soils include those having scanty vegetation. They are light-colored and unleached. A large part of the desert is wind-swept, rocky, or piled with sand; smooth, deep soils in it respond well to irrigation.

**Latosol.** Several great groups in the tropics and subtropics are included in the latosol. They are leached and relatively porous, and their constituent particles are highly weathered. The red latosols are strongly leached soils of the humid tropics. Although usually rich in clay, they are porous. Thus, quite strong slopes may be safely cultivated. To produce crops on them, the soil must be heavily fertilized, or returned to the forest for 12 or 15 years after short periods of cropping. The reddish-brown latosols, developed on basalt and similar rocks, are more productive. They are found near volcanos, as in Hawaii, and along the mountains of east Africa.

Ground water laterite is found in the tropics and subtropics on nearly level ground having pronounced wet and dry seasons. This soil is one of the most interesting but least productive in the world. In the wet season, the water table may come within 2 or 3 ft. of the surface, while in the dry season it may be many feet deep. The top surface horizons become thoroughly leached and acid. The material underneath undergoes a peculiar type of change. The soil material becomes doughy and can be cut out with a knife into bricks, but when exposed to the air for a few months, it hardens into a slag-like rock. It is called laterite. Once hardened, it is extremely resistant to weathering. Throughout the tropics, one may find large masses and areas of laterite, laterite crusts underlying almost any soil. In many latosols, small concretions of laterite are formed, rather than crusts.

The most productive soils in the tropics are young soils, such as the soils of steep slopes rejuvenated by erosion. When cultivated, such soils must be protected by terraces or strip cropping. Large areas of soils such as those in Java, for example, are kept fertile by frequent showers of volcanic ash.

An extremely wide range of crops can be grown on good latosols. Hundreds of millions of acres of good soils in the tropics are not yet cultivated.

In southeastern United States, an important group of soils, the red-yellow podzolic soils, lie between the gray-brown podzolic to the north and the latosols to the south. Like soils farther north, the surface layers are leached and are underlain by horizons rich in clay. But they are not so pervious as the latosols. Thus, when exposed to the rain, they erode easily—far more easily than the latosols. They can be built up to a high state of fertility, yet they share one handicap with the latosols: the soil material holds phosphorous very tightly. C. E. K.

## SOIL CONSERVATION

Soil conservation is the control of soil erosion by water and wind. Jared Eliot of Connecticut wrote the first American work on agriculture in 1748, calling attention to the loss of fertility due to soil erosion. Two generations later, in 1790, Samuel Deane of Maine wrote of wind erosion in a textbook on good farming. The rapid expansion to the West served to prevent the nation as a whole from realizing the great waste of timber and soil.

**Early Efforts Toward Soil Conservation.** The end of the nineteenth century witnessed the first general realization that the era of exploitation and waste of natural resources must end. In 1899, the first soil surveys were begun. In 1901, Theodore Roosevelt took up the campaign for conservation, assisted by the pioneer forester Gifford Pinchot.

*AIRVIEW OF CONTOUR PLOWING IN OKLAHOMA*

COURTESY OF STANDARD OIL CO. (N.J.)

Roosevelt enlisted the interest of the state governors in 1908, and secured action by Congress to protect the shrinking forest areas, mineral lands, and other resources. The U.S. Department of Agriculture and the state agricultural colleges continued to urge soil rehabilitation. In 1929, soil and water experiment stations were set up in ten areas where there were acute problems. In these stations, the methods of controlling erosion were worked out very much as they have been used ever since. The economic crisis of the early 1930's stimulated the organization, in 1933, of the Soil Erosion Service in the Interior Department as a relief measure.

*EXAMPLE OF SOIL CONSERVATION*

*Through the application of the essential soil mineral, phosphorus, and cover crops, the fertility of the field on the left has been restored as compared with the gullied, barren field on the right*

COURTESY OF DEPT. OF CONSERVATION & DEVELOPMENT, NORTH CAROLINA

**Soil Conservation Act.** The Soil Conservation Act, passed by Congress in April 1935, marked the beginning of a comprehensive, nation-wide attack on the problem of saving the soil. The principal advocate of this law was Hugh H. Bennett, a soil scientist in the Bureau of Soils of the Department of Agriculture. Bennett was made head of the new Soil Conservation Service, which was organized in the Department of Agriculture.

**Methods.** The operations of soil conservation include not only contour strip cropping, which has been practiced for thousands of years in most countries, but also terracing, drainage, fertilization, crop rotation, pasture improvement, dam and pond building, planting of woodland shelter belts and windbreaks, and many variations of these operations. *See also* CONSERVATION EDUCATION; DRAINAGE; GEOPHYSICS (*Hydrology*); HORTICULTURE; HYDROLOGY; INDUSTRIES, EXTRACTIVE (*Agriculture*); IRRIGATION; METEOROLOGY (*Climate*); SOILLESS HORTICULTURE. J. C. Ma.

**SOILLESS HORTICULTURE,** a general term applied to the art of growing plants without soil. Three systems or techniques are employed: the solution culture, the sand or gravel culture, and hydroponics.

Solution culture consists of growing plants with their roots immersed in a solution containing all the mineral elements known to be essential for their growth and development. Of the elements known to be necessary for plants, carbon, hydrogen, and oxygen are obtained by the plant from the atmosphere or from water absorbed from the growth medium. Potassium, calcium, magnesium, nitrogen, phosphorus, and sulphur—sometimes designated as the major elements; iron, manganese, boron, zinc, copper, and perhaps molybdenum—frequently referred to as micronutrients, or trace elements—are absorbed from mineral salts dissolved in the water surrounding the roots. Many culture solutions have been devised and are used successfully. One which has been used extensively contains in each liter of distilled water: 0.2 g. $KNO_3$, 0.2 g. $KH_2PO_4$, 0.8 g. $Ca(NO_3)_2 \cdot 4H_2O$, and 0.2 g. $MgSO_4 \cdot 7H_2O$. To this is added 1.0 cc. of a solution of micronutrient salts prepared by dissolving in a liter of water 1.0 g. $FeSO_4$; 1.5 g. $H_3BO_3$; 1.5 g., $MnCl_2 \cdot 4H_2O$; 0.1 g. $ZnCl_2$; 0.06 g. $CuCl_2 \cdot 2H_2O$; and 0.05 g. $MoO_3$. The solution must be renewed at appropriate intervals, either by replacing the old with fresh solution or by a method of continuous flow. Aeration must also be provided.

In sand culture or gravel culture, plants are grown in sand, gravel, or other chemically inert aggregate particles. The inert materials are kept moist by surface applications of the culture solution at suitable intervals. Good drainage is essential. A practical method for large-scale production is that of subirrigation, which requires watertight beds of the aggregate into which the culture solution is pumped from a reservoir at a lower level. After each flooding of the bed to within about an inch from the surface, the solution drains back into the reservoir by gravity. This method provides excellent aeration for the roots and can be made relatively automatic. It is commonly employed for greenhouse production of floricultural and horticultural crops.

Hydroponics is a term applied to a system of soilless culture which combines certain features of both solution and sand culture, and is used for the large-scale production of plants. Seeds or seedlings are planted in a bed of litter such as excelsior, wood shavings, peat, and sphagnum moss, or a mixture of these or similar materials, forming a porous mat supported on a tightly stretched, asphalted wire screen above the culture solution, which is contained in a shallow tank of convenient size. An air space of one or two inches between the solution surface and the porous mat is an important feature of this system. As the plants grow, they send some of their roots into the porous mat, which provides a firm support, while others penetrate into the solution, from which they absorb the inorganic elements necessary for growth. Some means of aerating and circulating the solution in the tank is sometimes necessary to obtain the best results. J. W. S.

**SOIL MECHANICS,** a branch of civil engineering in which the principles of physics and mechanics are applied to engineering design and to analysis of structures supported on or built of soil.

Soil mechanics, as it is currently known, had its actual beginning with the publication in 1925 of the classical *Erdbaumechanik* by Karl Terzaghi, the founder of modern analysis of soil action. The contribution of Terzaghi was a well-organized and realistic correlation of mechanics and empirical knowledge with true physical properties of soils determined by laboratory and field measurements. Within limited fields, this same approach was coincidentally applied by K. E. Petterson and W. Fellenius to earth slides in Sweden, and by D. E. Moran to settlement and foundation problems in the United States.

**Nature of Soils.** Soil, in soil mechanics, includes all material in the earth's crust that is not solid rock. It consists of accumulations of mineral particles from boulders to colloidal clay grains visible only in the electron microscope. The spaces between the mineral grains contain air, water, or both, and, in many surface soils and some other deposits, varying amounts of organic solids. Natural soils are the product of geologic forces of disintegration, transportation, and deposition. They vary widely in physical character with minor variations in the geologic history and processes.

**Classification.** The basic procedure of soil mechanics is to combine physical properties of soils, measured by laboratory or field tests, with stresses or mass forces, computed on a theoretical or semiempirical basis, to determine the action of the soil under, or in, an engineering structure. This procedure leads to a major division of subject matter into (1) physics of soils, and (2) mechanics of soils. Physics of soils is the study of physical properties of soils and methods for their quantitative measurement. It includes properties of individual mineral grains, mass properties for identification and classification of soils, and strength and deformation properties that govern behavior under load. Mechanics of soils is the study of stresses and mass forces in soils in typical engineering problems, utilizing the soil properties from soil physics to determine the safety of the engineering structure and also its performance. Within the mechanics of soils, two general types of soil action are of basic interest to the engineer. The first is actual shear or sliding failure in the soil due to insufficient strength to sustain applied loads. Actions of this type include stability of earth slopes, pressure of earth on retaining walls, ultimate bearing capacity of footings resting on soil, bearing capacity of piles, and all actions generically termed "problems of rupture." The second general type of soil action involves deformations of the soil too great for the supported structure to sustain without failure or improper functioning. It includes settlements of buildings, bridge piers, highway and airfield pavements, etc., and distribution of pressures on walls, tunnels, etc., all termed "problems of deformation." These two general types of soil action are quite independent, since the first involves soil failure while the second involves only deformation or yielding without approaching actual failure of the soil. Therefore, they are treated as separate groups of problems in soil mechanics. There are, in addition, problems in soil mechanics involving neither rupture nor deformations. These include the dynamics of pile driving, the flow of water through soils and analysis of seepage through dams, the production of wells and drainage, the mechanics of quicksand and its effects, and frost action in soils and its effects on highways, airfields, and structures. *See also* Building Construction; Dams; Foundations; Soil. P. C. R.

**SOISSONS** [swa′sõ′], a historic city of the department of Aisne in north central France, situated on the River Aisne about 65 mi. northeast of Paris. During Roman rule it was the chief town of the Suessones. Here in 486 the Romans were defeated by Clovis, King of the Franks. The town became the capital of the West Frankish kingdom of Neustria in 511. Among the chief reminders of its importance during the Middle Ages are the spires and cloisters of the abbey of St. Jean-des-Vignes (damaged by bombardments in World War I), founded in 1076, where Thomas à Becket spent nine years; the church of the abbey of St. Léger, with a crypt of the ninth and tenth centuries; and the remains of the abbey of St. Médard, where Louis the Pious was imprisoned by his sons in 833 and later Abélard was confined. The Cathedral of Notre Dame (partly ruined during World War I) exemplifies the mixed Romanesque and Gothic style of the twelfth and thirteenth centuries; the former church of St. Pierre-au-Parvis, dating from the twelfth, is Romanesque. Soissons is a market for grain, string beans, and sugar beets. The principal industries of Soissons include tire factories, tanneries, foundries, copper works, and other metal-working plants. Pop. 1954, 20,484. W. McE.

**SOISSONS, BATTLE OF** [swa′sõ′], A.D. 486, the first major victory of the Frankish king, Clovis, in which he defeated Syagrius, the last independent Roman administrator in Gaul. The Franks then annexed the territory north of the Loire River and eventually extended their sphere of influence southward. The Battle of Soissons marked the beginning of the rise of the Franks, and the end of the Roman domination of Gaul, which had existed since the time of Julius Caesar. T. B. J.

**SOL** [sɒl], the Roman god of the sun, identified with the Greek Helios. *See also* Helios.

**SOLANUM** [sole′nəm], a large genus of herbs, shrubs, and small trees of the nightshade family, found in temperate and tropical climates. Several species are of economic importance, including the potato, *S. tuberosum,* native probably to the Andes, and the eggplant, *S. melongena,* originally from southwest Asia. Others are of ornamental value, such as the bittersweet, *S. dulcamara,* naturalized in the United States from Europe, and the Jerusalem cherry, *S. pseudocapsicum,* also probably native to Europe. The flowers of this genus are often showy, wheel-shaped, or shallowly bell-shaped in various colors, including yellow, blue, purple, and white. The fruit is a fleshy, many-seeded berry. Some of the genus are climbers, and some are spiny. J. C. Wis.

**SOLAR HOUSE HEATING.** The use of solar energy for heating houses seems quite attractive from several viewpoints. First of all it could reduce substantially the consumption of our dwindling supplies of fossil fuels. This conclusion is supported by studies which show that space heating alone requires nearly 30 per cent of the fuel used annually in the United States. Less industrialized areas of the world devote even larger fractions of their fuel resources to space heating. Secondly, space heating occurs at such low temperatures that the fuel is used very inefficiently. For efficient usage fuel should be burned at a high temperature, 2,500° F. or more, with part of the heat used for power generation and the heat rejected from the prime mover finally utilized for space heating and other low-temperature purposes. Installations to accomplish this sequence are presently found only in ships and central power stations, and

are not regarded as feasible for individual homes or other moderate-sized buildings. Thus, the development of solar heating is of current interest and is the subject of some contemporary research.

The average dwelling house in the U. S. requires heat energy in amounts up to 400,000 B.t.u. per day or more. Studies of weather sequences and of the intensity of solar energy lead to the general conclusions that a solar collector for a dwelling house should have an area facing the sun of from 500 to 800 sq. ft. and that a heat storage unit should be provided with a capacity sufficient for operation during eight to 10 sunless days in succession.

Collectors for heating by solar energy consist of glass-covered black surfaces, oriented so as to receive a maximum of radiation from the sun. The function of the glass cover is to trap the solar energy. The solar energy is initially in the form of short-wave light rays. These rays are absorbed by the black surface, cause it to become hot and, therefore, to re-radiate part of the energy as long-wave infrared rays. The glass has a property which allows the short-wave rays to pass through but does not allow the long-wave rays to pass. Thus, energy accumulates in the enclosure; the temperature of the whole structure rises; the coverglass heats up, and the heat loss from the outside of the structure by convection and radiation approaches equality with the heat entering as short-wave light rays. Temperatures as high as 300° F. may be achieved in small closed structures with insulated bases and no cooling. However, useful application of the solar collector is accomplished by removing heat continuously from the absorber surface and thereby keeping the temperature comparatively low. If the absorber surface is made of metal, the heat may be carried away from it by the circulation of water or air across the plate, generally in metallic ducts or tubes in contact with the absorber plate. In another design the absorber surface is made of black glass strips, spaced away from the inner panel boundary so that air may flow over both sides of the strips and hence promote a high rate of heat flow.

A solar-heated dwelling house was constructed in Dover, Mass. in 1948. The Dover house has a heat collector in the form of a vertical panel 10 ft. high by 72 ft. long, forming the south outer wall of the attic space above the one-story house. The visible rays of the sun pass through the double-glass window panes and are absorbed on the black-painted, metal, rear wall of the collector unit, parallel to the glass panes and a few inches behind them. Air, circulated over the black surface by a fan and a system of baffles, is warmed by contact with the surface. The warm air may be used directly for heating the house during the day time and, at the same time, may be circulated through a heat storage unit to be used to supply heat during the night and sunless hours. The storage unit in the Dover house consists of a bin or closet containing many sealed cans of a chemical, such as sodium sulphate decahydrate, which freezes and melts at 90° F. and releases or absorbs over 100 B.t.u. per pound of chemical. The total weight of the canned chemical is 21 tons and its volume is 470 cu. ft.—small when compared to the total volume of 10,000 cu. ft. for the entire house. This quantity of chemical, when fully "charged" with heat, should provide enough heat for 10 sunless days.

During sunlit hours, air is circulated through the heat collector and the heat storage bin. When the air is warmer than 90° F., heat is transferred to the chemical and causes it to melt. At night, and during other sunless periods, air is circulated through the heat storage bin and the living space of the house, with dampers used to prevent circulation into, or out of, the then cold heat collector unit. When air flowing through the storage bin is colder than 90° F., it collects heat from the melted chemicals. This warms the air and causes the chemicals to solidify again. The Dover house is reported to have been adequately heated by the system during the six years of its history.

Other proposals for solar house heating differ from the Dover house not only in the form of the collector but also in the design of the heat storage unit. Two other experimental buildings have been constructed in the U. S. One, in Cambridge, Mass., used water as a heat transfer medium. It was heated in sunlit hours by passage through coils connected to the absorber panel which was placed behind glass on the sloping south face of the roof. The hot water was stored in an insulated tank placed in the attic. About 20 B.t.u. per day per pound of water could be stored, and the tank was large enough to carry the heating load for five successive sunless days.

Another experimental system was placed in a home in Colorado. It consisted of collector units placed between the rafters on the southern slope of the roof with heat storage provided by a pile of loose gravel placed in an insulated duct. The amount of gravel was sufficient only to provide heat during the night hours and a normal fuel-fired heating system was used on sunless days.

Each of the systems described above is still in the early stages of development. Based on current prices (1955) the cost would be several times that of conventional type heating systems. Solar collector efficiencies are of the order of 50 per cent or less and improvements in this unit alone could reduce costs considerably. Heat storage units need much improvement and will be feasible only if they can be made more compact. E. D. H.

**SOLAR MOTION,** the sun or the entire solar system, moving in space with reference to the nearer stars. This solar motion is at the rate of 12.2 mi./sec. or 4.2 astronomical units per year, and the direction of motion is toward a point in the constellation Hercules, a few degrees from Vega. This point, the apex of the sun's way, is at right ascension $18^h$ and declination $+30°$. The motion is known by the statistics of proper motions of many stars, and independently by their radial velocities. At the apex, the stars are moving toward the earth and slowly separating, while at the opposite point, the solar antapex, in Columba, they are closing in. Motion toward Hercules should not be confused with the sun's motion around the center of the Milky Way at a velocity of 160 mi./sec. *See also* SOLAR SYSTEM. H. S. R.

**SOLAR SYSTEM,** a unit of the universe, consisting of the sun, the nine major planets, their satellites, the minor planets, comets, meteors, and certain aggregates of small particles known as Zodiacal Light. It contains one star, the sun, about which all members of the solar family, except the satellites, revolve at various distances and speeds in accord with Kepler's laws of planetary motion.

One of the greatest scientific controversies of all time was waged over whether the earth or the sun was the center of the universe. Speculation regarding the motion and arrangement of the planetary bodies occupied the entire century and a half following the Renaissance, with two doctrines pervading the thought of this period. One, a direct carry-over from ancient times, was the concept of Aristotle that the earth was the center of the universe, and that all the planets and stars revolved around it. Aristotle's concept, although unchanged in fundamentals, was later modified by

Hipparchus, Ptolemy, and Tycho Brahe, in turn, better to explain certain planetary motions by means of a complex system of deferents and epicycles. The theory of these various authors was called the geocentric theory.

The second basic principle was originally proposed by Aristarchus about 250 B.C. The complete theory was not formally stated until the time of Copernicus, whose great work *De Revolutionibus,* reached him on his deathbed in 1543. This latter (heliocentric) concept—that all objects composing the solar system revolve ultimately around the sun as center—is now considered to be the true one. So strongly was the authority of Aristotle's teachings entrenched in the minds of the people, that it took more than 2,000 yrs. after the original pronouncement of the Aristotelian theory for its final dissolution. The great scientific achievements of Kepler, Galileo, and Newton were instrumental in bringing about this victory over dogma. Both heliocentric and geocentric theories were taught in the earliest American universities, Harvard and Yale, for a number of years.

## SUN

The sun is the center of the solar system and the closest star to the earth. It appears larger and brighter than any of the other stars because of its comparative nearness—a distance of 93 million miles compared with the 25 trillion miles of the next closest star. Physically, the sun is a huge ball of glowing gas and incandescent vapors, with an average surface temperature of approximately 6,000° C. (11,000° F.), increasing to an estimated 10,000,000° C. (or more) deep in the interior.

**Radiant Energy.** The radiant energy of the sun is created by the continuous transmutation of its chemical elements, known as the carbon-cycle, and the energy thus produced is manifest as heat and light. The process responsible for the light of the sun is not one involving actual burning; solar temperatures are well above those at which normal oxygen combustion processes may occur. The radiation of the sun is produced by atomic processes. Streaming outward from the surface of the sun in all directions into space is an enormous quantity of radiant energy, whose continuous outflow results in a reduction in the mass of the sun at the rate of 4,000,000 tons each second.

Assuming the intervening space to be completely transparent, the radiant energy which reaches the outer limits of the earth's atmosphere and falls perpendicularly upon each square inch thereof is only 3/10,000,000,000 of the original energy which leaves the sun's surface. By the loss of as little as five per cent of this incident radiant energy, human life would perish on a frozen terrestrial sphere.

**Size and Appearance.** The sun is 865,370 mi. in diameter; its mass is 333,434 times, and its volume more than 1,000,000 times, that of the earth. In terms of size, mass, temperature, and physical characteristics, it is only an average stellar object. The visible surface of the sun as seen with the aid of very dark glasses or through a considerable depth of fog or smoke is the incandescent layer of solar atmosphere known as the photosphere. This luminous surface reveals a mottled "rice-grain" appearance, with each bright fleck or granule measuring hundreds of miles in diameter. Brilliant patches of luminosity, visible on the solar disk in ordinary light, are known as faculae.

**Sunspots.** Isolated dark areas on the sun, first observed telescopically by Galileo, although known through naked-eye observations by the ancient Chinese, are called sunspots. They are huge whirling vortices in the solar atmosphere, representing zones of intense disturbance. While the temperature within a sunspot is several thousands of degrees, the difference in temperature between the sunspot and the photosphere amounts to about 2,000°, or sufficient to produce a comparative difference in luminosity.

Sunspots follow a definite cycle of occurrence. From the results of observations extending well back into the eighteenth century, it is found that, on the average, spots reach a maximum frequency of occurrence every 11.1 years. At the time of sunspot maximum, the disk of the sun may be covered with spots. At sunspot minimum, weeks may pass without a single spot appearing on the photosphere of the sun. Sunspots move from higher latitudes at the beginning of each

FROM MT. WILSON OBSERVATORY, COURTESY OF AMERICAN MUSEUM OF NATURAL HISTORY

*Direct photograph of sun showing sunspots*

new cycle, to low latitudes as the cycle dies out. The spots almost invariably occur in pairs, or in two separate clusters, possessing opposite magnetic polarity, and acting as huge centers of electromagnetic activity. The polarity of the preceding and following spots of each group is opposite in the northern and southern solar hemisphere, and the polarity of all spots is reversed with a new sunspot cycle.

The sun rotates on its axis in a counterclockwise direction looking down from the north ecliptic pole. The period of rotation is 25 days at the equator, varying to a maximum of 34 days near the sun's pole. This motion of rotation also carries the sunspots across the disk of the sun from east to west with respect to cardinal points on the earth's horizon, so that the same spot is only visible for about two weeks on the earth's side of the sun before it disappears.

*Influence of Sunspots.* Sunspots affect the course of earthly events through physical connection with certain electrical and magnetic phenomena in the earth's atmosphere. These events include displays of the aurora borealis and aurora australis, and short-wave radio fadeouts, both of which are very prevalent at times of sunspot maxima. Statistical correlations between sunspot activity and long-period, climatological changes are possible, but frequency of sunspots, alone, bears no proved relationship to day-to-day weather at any one point on the earth's surface. Chromospheric flares are also seemingly influential in causing short-wave radio fadeouts. As seen in a spectrohelioscope, solar flares resemble the splash

COURTESY OF LICK OBSERVATORY

TOTAL SOLAR ECLIPSE, AUG. 31, 1932

*The corona exhibits characteristic short, brushlike filaments near the sun's poles, and broad, high streamers near its equator.*

of fluid rising around a stone dropped onto a water surface. These flares emit large bursts of ultraviolet radiation, which is ultimately effective in increasing the ionization of the earth's upper atmosphere. A lag period of approximately 26 to 36 hrs. seems to occur quite commonly between the appearance of a sunspot on the sun's central meridian and the occurrence of any electromagnetic effect in the earth's atmosphere. However, the time between the first outbreak of flare activity on the sun and the corresponding radio disturbance on earth is a matter of minutes. This suggests that the cause of the radio fadeout is the influx of ultraviolet radiation traveling with the speed of light, since the "light-time" from the sun to the earth is only eight minutes.

The reason for the direct correlation between radio reception and solar activity lies in the fact that the sun is itself the agent which makes radio transmission possible on the earth. Were it not for the stream of electron particles projected from the sun and continuously entering the earth's upper atmosphere, long-range radio reception would be unknown. The penetration of this electron stream from the sun into the earth's upper atmosphere results in several electrified or ionized layers at levels ranging (during a 24-hr. period) from 30 to 175 mi. above the earth's surface. One of the most significant of these is the Kennelly-Heaviside ($E_1$) layer. This electrically charged layer acts as a barrier to conventional broadcast-band radio signals transmitted from the surface of the earth, which would otherwise proceed unimpeded into space. Due to the "radio roof" imposed by this ionized layer sky-wave radio signals are reflected back toward the earth's surface, and may be picked up by a receiver at a distant point. During the day, with the sun in the sky, the Heaviside layer is depressed to about 70 mi. above the earth's surface by the magnitude of the electron stream, and the range of radio reception is limited. At night, in the absence of the sun, and subject to a diminished electron stream, this layer rises to a point around 100 mi., and radio reception is possible at greater effective distances. Similar relationships, involving different ionization levels, apply to the Appleton ($F$) layer, and short-wave radio reception, where fadeouts are even more pronounced. At times when solar flares are prominent, and near sunspot maxima, the earth's ionospheric layers are distorted, radio signals are affected, and short-wave radio reception may be completely impaired for brief periods. Occasionally, when a particularly large spot or spot-group appears on the side of the sun turned toward the earth, both short- and long-wave radio reception may be marred by static, short-wave radio signals may fade out completely, teletype, land-line, and leased-wire facilities are badly disrupted by garbled transmissions, and even telephone communication is affected.

**Solar Eclipses.** Solar eclipses are produced as the moon, in its revolution around the earth, passes directly between earth and sun, and temporarily obscures the luminous solar disk. The moon's orbit about the earth is inclined approximately 5° to the plane of the earth's orbit about the sun (ecliptic). Accordingly, although the moon reaches a position of alignment with the earth and the sun once each monthly revolution, the moon's position then lies generally above or below the ecliptic plane. It is only at, or near, the points where the moon crosses the ecliptic from south to north, or the reverse, during its revolution, that a total eclipse, either solar or lunar, is possible. For an eclipse to occur, this junction, or nodal point, must also lie along a straight line connecting earth, moon, and sun.

It is possible to have a maximum of five solar, and two lunar, or four solar and three lunar eclipses, in any one year; however, there must be at least two solar eclipses each year. The 18-yr. recurring cycle (19 eclipse years), known as the saros and utilized to determine the time at which the same eclipse will again occur, was known to the ancient Babylonians as early as the sixth century B.C. Theodore von Oppolzer, nineteenth-century Viennese astronomer, employed this relationship to compile a series of tables, the *Canon der Finsternisse*. This monumental work contains data on 8,000 solar and 5,200 lunar eclipses occurring between 1207 B.C. and A.D. 2162.

The sun is approximately 400 times the moon's distance from the earth, but 400 times larger in actual diameter than the moon. Therefore, when viewed in the sky, the sun and the moon have the same apparent dimensions, as seen by the naked eye. When the moon's disk is superimposed upon that of the sun it may completely cover the sun.

A solar eclipse can take place only at time of new moon. As the moon moves in front of the sun, a long narrow shadow cone is projected by the opaque body of the moon, and extends across space toward the earth. The shadow cone cuts a swathe of darkness, averaging about 100 mi. in width, across the earth's surface. The earth's rotation combined with the moon's orbital velocity in the same direction causes the shadow cone to sweep with a speed of 1000 to 5000 mi. per hr. across the continents and seas, the exact speed depending upon the angle of the shadow cone and the horizon.

Complete obscuration of the sun's disk by the moon's opaque body is a total eclipse. Because of the elliptical shape of the moon's orbit, its distance from the earth varies through more than 31,000 mi. at each monthly revolution. The apparent size of the moon's disk, therefore, changes by a slight amount depending upon its distance from the earth. During a solar eclipse that occurs while the moon is at its greatest distance from the earth (apogee) and has its smallest angular diameter, the whole disk of the sun may not be covered by the moon. At this time, a thin ring or "annulus" of light surrounds the lunar sphere, and the eclipse is described as annular. If the moon's position with respect to the ecliptic causes the moon, at maximum eclipse, to obscure only a portion of the sun's disk, a partial solar eclipse results. While a lunar eclipse may last as long as 1 hr. 40 min., the total solar eclipse generally lasts only brief seconds, with a maximum duration of 7 min. 31 sec., when observed under the most favorable conditions at the earth's equator.

In the brief instants of totality, features of remarkable form and color become visible, on and surrounding the solar limb. At the instant of totality, a pearl-white appendage known as the corona flashes into view around the periphery of the sun, and extends many hundreds of thousands of miles above its limb.

As the rays of the sun project over the moon's edge and shine between adjacent highlands, segmented beads of light are often produced by irradiation. Brilliant spots of luminosity known as Baily's beads are then seen on the moon's circumference. When a particularly dazzling point of light blazes forth at a single position on the moon's limb, the illusion of a sparkling diamond set within a narrow band of luminosity is afforded; this singular occurrence is called the diamond ring. Much of scientific value may be obtained from systematic observation of various phenomena during the course of a total solar eclipse.

**Solar Powerhouse.** The sun is a vast powerhouse of atomic energy, possessing extremes of temperature, pressure, and density wholly unattainable in earthly laboratories. Observation of the sun, therefore, provides a means for studying many complex reactions of physics and chemistry under conditions otherwise impossible.

The principal gaseous constituents of the sun's upper atmosphere are hydrogen, the lightest gas known, and helium, the second-lightest chemical element. Also, a rather large number of solid elements are converted by the high temperatures prevailing on the sun into a vapor state. The metallic vapors which exist in relatively great abundance in the solar atmosphere are calcium, iron, magnesium, and nickel. Some 66 of the 98 elements now known on earth have been positively identified in the sun. The third most abundant element is carbon, which represents only a trace compared to hydrogen.

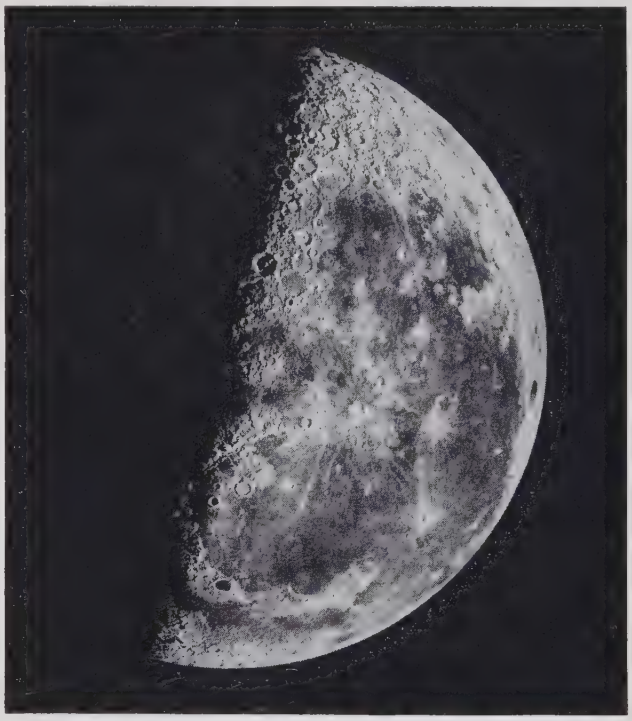
The over-all visible surface or photosphere of the sun as revealed by the aid of a spectrohelioscope is seen to be in a continuous surging motion. This glowing mass of high-pressure gas would give a continuous spectrum by itself. Above the photosphere, and surrounding the sun as a comparatively shallow though indeterminate outer shell, is a semi-transparent layer, the chromosphere. This comparatively cooler gas at lower pressure would give a bright-line spectrum by itself. The base of the chromosphere is sometimes called the reversing-layer, since the superposition of this bright-line source on top of a continuous-spectrum source results in absorption of light in comparable wave-lengths from the continuous spectrum of the photosphere, and the production of the sun's characteristic dark-line or Fraunhofer spectrum.

Projecting upward from the edge of the chromosphere are great tongues of gas and vapor known as solar prominences. At the high temperatures of the chromosphere, the prominences can consist only of clouds of ionized gas, not of flames. Prominences often extend many hundreds of thousands of miles above the sun's limb, and may have internal velocities in excess of 100 mi. per sec. They frequently resemble great feathery plumes on the edge of the sun and, in high-speed motion picture photography, reveal a bewildering composite of motions.

## MOON

The moon (the earth's satellite) is a spheroidal body 2,162 mi. in diameter, or about ¼ the actual diameter of the earth. It revolves around the earth in a period (sidereal) of 27⅓ days, at a mean distance of 238,857 miles. Like all other satellites and planets, the moon shines by reflected light of the sun. Telescopic study is unmarred by the presence of atmosphere or clouds, and the structural details of the moon have been carefully mapped.

**Selenography.** Among the large-scale topographic features are the dark areas named by Galileo lunar "seas" or maria. There is, however, no water on the moon, and the maria are actually vast smooth plains, appearing darker by contrast with the mountainous areas, *Mare Serenitatis, Mare Tranquillitatis, Mare Imbrium, Mare Nubium,* and *Mare Nectaris,* with diameters up to 700 mi., and more, are examples of the Latin designations used. A larger area in the eastern area of the moon is the *Oceanus Procellarum.* Lesser extensions of the maria are known by the designations of *sinus* (bay), *lacus* (lake), and *palus* (marsh).



COURTESY OF LICK OBSERVATORY

*DIRECT PHOTOGRAPH OF MOON AT LAST QUARTER*

*The crater* Copernicus, *with diverging rays, is visible near the center of the photograph.* Eratosthenes *lies to the left and below. A curved line, extending from these, passes successively through the large craters,* Archimedes *and* Plato. *The Apennine Mts., 600 mi. long and with peaks 18,000 ft. high, also curve downward to the left from* Eratosthenes. *The lunar Alps merge into the terminator, above and to the left of* Plato. *The darkest area in the upper left portion is the* Mare Nubium, *a vast lunar plain. The Straight Wall, an escarpment 60 mi. long and 900 ft. high, is visible as a thin streak along the left boundary of this plain.*

Crossing the lunar plains are mountain ranges similar to those of earth. Several of these have been named after terrestrial counterparts, such as the Alps, Caucasus, and Apennines. The last-named range is about 600 mi. long and contains more than 3,000 peaks. Its average elevation is 18,000 ft. above the level of *Mare Imbrium.* Other mountain chains close to the limb of the moon, such as the Leibniz Mts., reach as high as 25,000 ft. Isolated peaks are numerous, a typical example being Pico, which rises 8000 ft. above the level of *Mare Imbrium.*

Distributed at random over the surface of the moon are ring-shaped formations known as craters. These range from about 500 ft. to 150 mi. in diameter. More than 32,000 craters are to be seen on the total illuminated disk of the moon visible to earth at full phase. They are sometimes

classified by several types, the largest being called walled plains, the intermediate craters ring plains, and the smallest craters proper. One of the most distinctive craters of the southern hemisphere is Tycho, a ring plain with a diameter of 54 miles. Bright streaks which radiate from the region of certain craters, notably Aristarchus, Aristillus, Copernicus, Euler, Kepler, and Tycho, are called rays. Gorges, cliffs, ravines, and valleys may all be seen as features of the lunar landscape. Other minor features include clefts, rills, and faults, most of which are indistinguishable except with larger telescopes.

Since the moon possesses no atmosphere, it has no means of softening the intense rays of light which stream toward it from the sun. These rays are transformed into heat upon contact with the lunar surface, and the temperature rises to extreme values on the illuminated portions of the moon. In the unlighted hemisphere, and wherever there is shadow, a startling temperature contrast prevails. The same lack of atmosphere also fails to provide a "reservoir" for the storage of heat energy from the sun: there is no "greenhouse effect" such as the earth's atmosphere provides, and heat temporarily absorbed by the lunar surface while exposed to the sun's rays very quickly escapes into space. Through measurements of the albedo of the moon compared with that of terrestrial rocks, it is believed that the surface of the moon is covered with a thin layer of pulverized dust or ash—an equally poor absorber and radiator of heat. Remote instrumental measurements show that at a point on the equator, the surface exposed to the direct overhead rays of the sun attains a temperature in excess of 212° F. When this point moves into an area of shadow, the temperature falls gradually to below —240° F.

The moon is a "dead world": because of the total absence of atmosphere and its related forces of weathering and erosion, the surface remains practically unaltered throughout time, without transporting winds, and even more barren and immutable than the polar wastes of earth.

The moon has an equal sidereal period of rotation and of revolution; it always keeps the same side turned toward the earth, the other side remaining a mystery. However, because of various small motions, known as librations, an observer on earth is permitted to see slightly more than half of the features of the lunar surface during any lunar month.

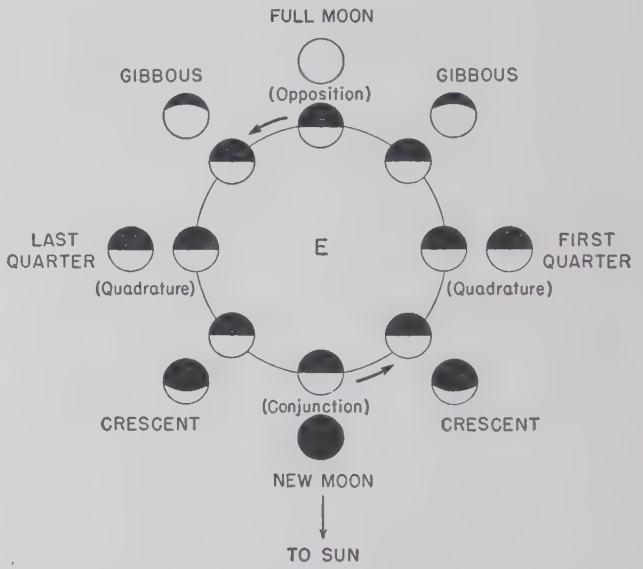
**Phases of the Moon.** Phases of the moon result from the relative positions of earth, moon, and sun. Since the moon shines only by the light received from the sun, except a small quantity of "earthshine" reflected from the earth and visible near the crescent phase, ordinarily only that portion of the moon illuminated by the sun's rays can be seen.

The phases of the moon have nothing to do with the weather, with crop growth, or any of the other superstitions or fallacies so prevalent in everyday literature. The only important influence of the moon on the earth is the physical force entailed in its gravitational pull and tidal action on the ocean waters. The motions and phases of the moon are used as a determining factor in the calculation of dates of church holidays and festivals.

**Lunation.** Lunation is the period of time, averaging approximately 29½ days, which elapses between successive new moons.

**Lunar Eclipses.** Lunar eclipses are produced at full moon, as the moon moves into the shadow cone cast by the earth on the side away from the sun. Once in each synodic revolution of 29½ days, the moon passes behind the earth to a point in a plane with the earth and sun, at time of full moon. The inclination of the moon's orbit with the earth's orbital plane prevents a lunar eclipse at each revolution, for the moon usually passes above or below the earth's shadow. Only when the moon is crossing the ecliptic plane at the same time it reaches alignment with earth and sun is a lunar eclipse possible. The moon then moves directly into the earth's shadow and the reflected sunlight from the moon's surface is extinguished. At total eclipse, the moon does shine, however, with a dull coppery glow, as the rays of the sun, passing laterally through the earth's atmosphere, are refracted into the shadow cone and project a small quantity of light and color upon the moon. The blue rays of sunlight are absorbed by the earth's atmosphere more than the red, and only the latter get through.

Within the shadow cone cast by the earth, two zones of unequal shadow intensity are formed. The innermost and darkest portion is the *umbra,* and the lighter ring of shadow surrounding the central dark core is the *penumbra.* At the




PHASES OF THE MOON

*The inner ring of moons shows position of the moon in its orbit around the earth (E), while the outer ring shows the corresponding phase appearance of the moon as seen from the earth. The arrows along the orbit show the eastward direction of revolution of the moon around the earth.*

average distance of the moon from the earth, the diameter of the umbra cone is about 5,700 mi. The moon travels in its orbit at about 2,300 mi. per hr. The duration of a total lunar eclipse may be therefore, when central, about 1½ hours.

**Lunar Occultations.** A more frequent phenomenon is the occultation of another celestial object. As the moon passes in front of a vastly more distant star, the light from the star is obscured, and the pointlike image is abruptly extinguished. The very suddenness of the disappearance is an observable proof of the absence of any lunar atmosphere; the existence of an atmosphere would cause the star's light to fade gradually. Occultations of a planet by the moon may also occur. Occultations are of value in checking the precise motions of the planets, and of the moon itself.

**Lunar Conditions.** The absence of any atmosphere on the moon precludes the existence of any water there. It also means that, as seen from the moon, the sun and stars would shine from a totally dark sky, free from the light-scattering effects of air particles. Where there is no air to transmit sound, there would be no sound heard by the ear. The lack of atmosphere on the moon is attributable to its low surface gravity, which is a function of the mass of the body. Because

of the smaller size and lesser mass of the moon in comparison with the earth, there exists a correspondingly smaller force of gravity on the moon's surface, approximating only 1/6 that of the earth. Accordingly, an object which on earth weighed 100 lb. would weigh only 17 lb. on the moon.

**Illusions, Superstitions, Phenomena.** *Harvest Moon.* The harvest moon is that full moon which occurs closest to the time of the September equinox. At this time, the full moon rises about the same time for several nights in succession, and this is supposed to provide additional hours in the day for the farmer to harvest his crops before the onset of winter; hence its name. This phenomenon occurs because of the shallow angle between the moon's orbit and the horizon, causing the moon's ascent to be gradual.

*Hunter's Moon.* The next succeeding full moon after the harvest moon, also slow in rising, is termed the hunter's moon, in honor of the appropriate season.

*Wet Moon.* The "wet moon" is purely superstition, it being originally supposed in legend that when the crescent moon was horizontal, with the horns upright, it would hold much water; if the moon was nearly vertical, and the horns sharply tipped, a dry season was indicated.

*Blue Moon.* The "blue moon" is a comparatively rare meteorological manifestation having its basis in physical fact —the selective scattering and absorption properties of small particles for light-rays.

*Others.* The adage of the "old moon in the new moon's arms" or "the old moon sitting in the lap of the new" is a popular phrase used to indicate the moon's appearance as seen shortly after new moon. The formerly invisible portion of the old moon is dimly illuminated by earthshine reflected from earth back onto the moon, and is seen couched in the brightly lit crescent of the waxing new moon.

The phenomenon by which the apparent disk of the moon is made larger when seen in the zenith than when on the horizon, due to the fact that the observer is 4,000 mi. nearer to the moon when it is directly overhead, is known as augmentation. This physical paradox is in direct contrast to the optical illusion by which the moon seems larger when seen near the horizon, an appearance which is produced by physiological response within the eye. The apparent elliptical shape of the moon (and sun) when seen near the horizon is caused by differential atmospheric refraction.

## PLANETS

A planet is one of a number of great, solid spheroids, shining by reflected solar light and circling forever in orbits around the sun. Going outward from the sun, the major planets, in order, are: the inferior planets, Mercury and Venus; the Earth; and the superior planets, Mars, Jupiter, Saturn, Uranus, Neptune, and Pluto. The orbits of the inferior planets lie within the earth's orbit, and the orbits of the superior planets are outside the earth's.

To the unaided eye, the planets look like stars, but in the telescope they appear as disks; whereas the stars are always points of light. Mercury, Venus, Mars, Jupiter, and Saturn were known to the ancients, while the others have been discovered in modern times. Planets are exceedingly small, compared to the enormous distances separating them. They all revolve around the sun in the same direction—counterclockwise, looking down from the north ecliptic pole. Mercury and Venus present moon's phases to observers on the earth but the superior planets show mostly the full phase.

Mercury, Venus, and Mars are dense planets, resembling the earth physically in many ways. Except for Pluto and Mars, the other outer planets show various dissimilarities with the inner planets, being much larger and less dense. Besides the major planets, there are thousands of minor planets, or asteroids, whose orbits are chiefly but not entirely confined to the zone between the orbits of Mars and Jupiter.

The sun, having a large part of the mass of the solar system, is the central dominating figure controlling the motions of all of the planets, and Jupiter, the largest planet, is next in gravitational control. The planes of the orbits of the major planets nearly coincide with the ecliptic plane, except that Mercury's is inclined 7° and Pluto's 17° to the ecliptic; the minor planets have inclinations up to 43°.

As seen from the earth, the inferior planets pass successively through inferior conjunction with the sun, western elongation, superior conjunction, eastern elongation, and inferior conjunction; the superior planets pass through conjunction, western quadrature, opposition, eastern quadrature, and conjunction. The predicted daily positions of planets are given in the national ephemerides. The regular or forward apparent motion of the planets is eastward among the stars, but during part of the year they are seen to move in a western or retrograde direction. The latter effect is caused by the relative orbital motions of the planet and the earth.

A planet may be distinguished from a star by the following tests: (1) Mercury, Venus, Mars, Jupiter, and Saturn possess great brightness. All of them under favorable conditions, outshine the stars; and among them only the luminosity of Saturn is exceeded by that of the brightest star, Sirius. Uranus, Neptune, and Pluto are faint objects. (2) All of the planets appear to move with respect to the stars. (3) Unless close to the horizon, a planet, which possesses a finite reflecting surface, usually shines with a much steadier light than the stars, which appear to twinkle due to interference patterns produced, in radiation from a point-source, by the earth's atmosphere.

**Mercury.** Mercury is the smallest of the nine planets, and revolves nearest to the sun. This planet is only 3,100 mi. in diameter, and is therefore exceeded in size by several of the satellites of the solar system. Mercury requires only 88 days to complete its revolution, so that it passes through four of its years in one terrestrial year. Its rapid apparent movement in the sky caused the planet to be associated in Roman mythology with the name of the wing-footed messenger of the gods; the Greek equivalent was Hermes. At an average distance of only 36,000,000 mi. from the sun, Mercury attains a surface temperature above the melting point of lead, or about 770° F. Since its period of rotation is the same as its revolution, Mercury always keeps the same side toward the sun, although presenting all sides successively to the earth. The side turned toward the sun is constantly subject to tremendous heat, while the opposite, dark side approximates the cold of outer space. Any portion of the illuminated surface of Mercury receives nearly seven times as much light and heat as a similar position on the earth. Mercury's closest approach to the earth is 50,000,000 miles.

**Venus.** Venus completes a circuit of its orbit once every 225 days. Venus is the sister planet of the earth, having a diameter of 7,575 mi. and possessing several other factors of similarity. Called Aphrodite by the Greeks, and Venus by the Romans, after the goddess of beauty, it is the brightest planet. At an average distance of 67,270,000 mi. from the sun, it receives twice as much light and heat energy as the earth. The planet may be seen by the unaided eye in broad daylight, if its direction is known. At maximum brilliancy, it is twelve times brighter than the brightest star, Sirius. At its closest approach to the earth, Venus is within 26,000,000 miles. Recent investigations show that the ro-

FACTS ABOUT THE SUN, MOON, AND MAJOR PLANETS

| *Name* | *Symbol* | *Diameter (miles)* | *Mass (earth=1)* | *Density (water=1)* | *Surface Gravity (earth=1)* | *Mean Dist. from Sun (millions of miles)* | *Sidereal Rotation Period* | *Sidereal Revolution Period (basis of earth's year)* | *Known Satellites* |
|---|---|---|---|---|---|---|---|---|---|
| Sun | ☉ | 865,370 | 333,434 | 1.43 | 28.0 | ..... | 25 days (E)<br>34 days (P) | ..... | ..... |
| Moon | ☾ | 2,162 | 0.0123 | 3.33 | 0.2 | *238,857 mi. | 27.32 days | *27.32 days | ..... |
| Mercury | ☿ | 3,100 | 0.037 | 2.86 | 0.2 | 36.00 | 88 days | 0.241 | 0 |
| Venus | ♀ | 7,575 | 0.826 | 4.86 | 0.8 | 67.27 | few weeks | 0.615 | 0 |
| Earth | ⊕ | 7,927(E)<br>7,900(P) | 1.000 | 5.52 | 1.0 | 93.003 | 23.934 hr. | 1.000 | 1 |
| Mars | ♂ | 4,268(E)<br>4,243(P) | 0.108 | 3.84 | 0.4 | 141.71 | 24.623 hr. | 1.881 | 2 |
| Jupiter | ♃ | 89,329(E)<br>83,854(P) | 318.4 | 1.30 | 2.5 | 483.9 | 9.842 hr.(E)<br>9.928 hr.(P) | 11.862 | 12 |
| Saturn | ♄ | 75,021(E)<br>67,805(P) | 95.2 | 0.69 | 1.0 | 887.2 | 10.0 hr. | 29.458 | 9 |
| Uranus | ♅ | 33,219 | 14.6 | 1.10 | 0.8 | 1,784.8 | 10.8 hr. | 84.015 | 5 |
| Neptune | ♆ | 30,917<br>†(27,700) | 17.3 | 1.62 | 1.1 | 2,796.7 | 15.8 hr. | 164.788 | 2 |
| Pluto | ♇ | 3,600 | 1(?) | ? | ? | 3,675.3 | ? | 248.430 | 0 |

NOTE: Values in table are based on a solar parallax of 8".790 and earth's mean equatorial radius of 3963.350 mi.
*With reference to earth †Recent independent measurement by Kuiper (E) At equator (P) At poles

FROM LOWELL OBSERVATORY. COURTESY OF AMERICAN MUSEUM OF NATURAL HISTORY

*Phases of Venus, showing relative apparent size in varying phases*

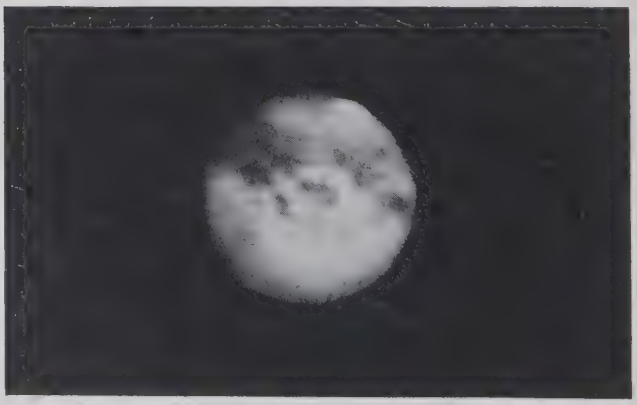
tation period of Venus must be several weeks, although less than 225 days.

**Mars.** Mars is important in connection with the contributions to science of the Danish astronomer, Tycho Brahe. His precise observations of Mars' positions largely provided the material upon which the theoretical calculations and important astronomical laws of Kepler and Newton were subsequently based. Almost paradoxically, in the realm of future knowledge, Mars also occupies first place in the imagination of those who envision the conquest of space. Telescopic study of this planet, its surface markings, and of possibilities of life has been a part of observatory work-programs by such careful investigators as Schiaparelli, Flammarion, Lowell, W. H. Pickering, Douglass, Antoniadi, Lampland, V. M. and E. C. Slipher, and Kuiper.

Mars measures 4,268 mi. in equatorial diameter, or slightly over one-half the size of the earth. At its greatest magnitude (−2.8), it appears brighter than any star except the sun and outshines all of the planets with the exception of Venus.

The comparatively large eccentricity of Mars' orbit causes the distance of this planet from the earth to vary between 35,000,000 and 63,000,000 mi. at opposition times alone.

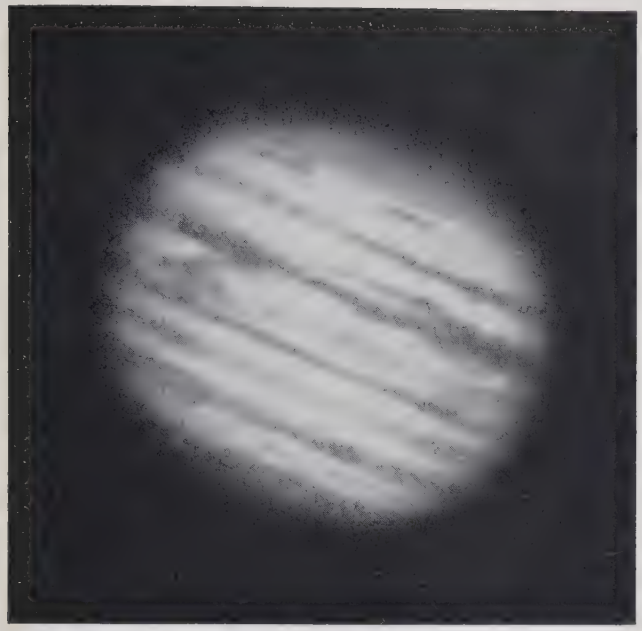
Seen through a large telescope and under ideal atmospheric conditions, the surface of Mars reveals many markings, permanent and transient. Foremost of these surface features are the Martian polar caps. Usually only one fully-developed cap is visible. This brilliant white area may be observed surrounding either the north or south pole, during the appropriate Martian season. Since the Martian year contains 687 terrestrial days, its seasons are almost twice as long as the earthly seasons, and at a distance of 1.5 times the earth's



COURTESY OF LICK OBSERVATORY

*MARS*

*The southern polar cap (image of Mars inverted by telescope) is seen as a bright, white spot at upper right. Surface markings are visible through 60 mi. depth of the atmosphere. The* Solis Lacus *appears as a dark, hook-shaped formation near the center. The thin, dark peninsula to its left, and slightly below, is* Tithonius Lacus, *extending from the* Aurorae Sinus. *The large dark area in the upper left portion is* Erythraeum Mare, *and the dark patch in the extreme right center is the* Mare Sirenum. *The* Aonius Sinus *is to the upper right of* Solis Lacus.



COURTESY OF LICK OBSERVATORY

*JUPITER*

*The light and dark bands are varicolored atmospheric clouds, parallel to the equator, and of constantly changing pattern. These clouds consist of methane gas and frozen crystals of ammonia. Note the greater equatorial diameter as compared with the polar diameter, resulting from the high rotational speed of this planet.*

distance from the sun, all seasons are considerably colder. The rotation period of Mars is slightly more than 24½ hrs.

Spectroscopic analysis of the atmosphere of Mars has shown that the amount of free oxygen present cannot exceed 1/1000 by volume of that existing in the atmosphere of the earth. No methane, ammonia, or nitric oxid have been detected in Mars' atmosphere. Similar studies likewise preclude the existence of water vapor in amount over 3 per cent of that found in the atmosphere of the earth. This does not rule out the possibility of even more minute quantities of water being sustained in vapor form by the Martian atmosphere. The atmosphere is about 60 mi. deep, though of extremely small density. Due to lower surface gravity, the atmospheric density does not decrease as rapidly with elevation above the surface as it does on earth, nor will the temperature-drop with increasing altitude be as severe.

*Satellites of Mars.* Mars is accompanied in its revolution around the sun by two satellites, Deimos and Phobos, fragments of rock only an estimated 5 and 10 mi. in diameter, respectively, and visible only in the largest telescopes. The revolution of Phobos is unique in the solar system in being less than one-third the rotation period of its planet.

**Jupiter.** Jupiter, the largest planet, is the fifth in order of distance from the sun and, next to Venus, is usually the brightest planet. It measures 89,329 mi. in equatorial diameter.

Jupiter revolves around the sun in a period equal to almost 12 terrestrial years, at an average distance of 483,900,000 miles. Because of this great distance and the small quantity of sunlight received, the maximum temperature at the surface is −216° F. Its closest approach to the earth brings it within 367,000,000 miles.

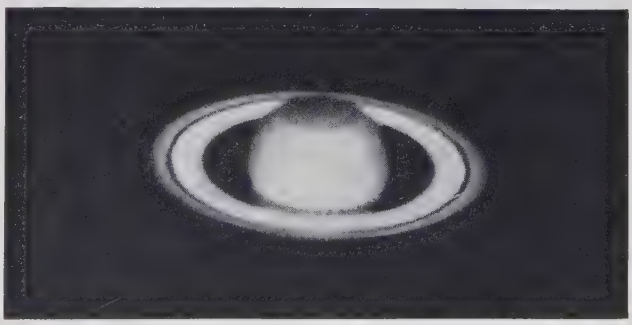
This planet is surrounded by a deep blanket of atmosphere, composed principally of methane, frozen crystals of ammonia, and ammonia vapor. An abundance of free hydrogen is also present. This atmosphere is believed to extend to a height of 8,000 mi. above a thick layer of ice which overlies a rock core. The period of rotation of Jupiter is only 9 hr., 50 min. at the equator, although, due to its predominantly gaseous composition, the period increases toward higher latitudes.

*Satellites of Jupiter.* Jupiter has 12 known satellites. The four largest and brightest moons (Io, Europa, Ganymede, and Callisto) are known as the Galilean satellites in honor of their discoverer, Galileo Galilei. One other fainter satellite lies closer to the primary. Io, Ganymede, and Callisto are all equal to, or larger than, the earth's moon. The last two are more than 3,200 mi. in diameter—larger than Mercury. All four may be seen easily through binoculars. They may all appear on one side of the planet, or be separated by the primary. Not all four moons are necessarily visible at the same time.

**Saturn.** Saturn is the sixth planet from the sun and, with its equatorial diameter of 75,021 mi. constitutes the second largest planet in the solar system: 734 bodies the size of the earth could be packed within its bulk.

To the unaided eye, the yellowish starlike image of Saturn presents no aspect of unusual nature, aside from its luminosity, which is greater than that of any of the stars except Sirius. As seen through a telescope, however, Saturn is the most picturesque planetary object in the sky. It then appears as a shining central sphere, girdled by a remarkable flat, ribbonlike ring. Upon closer inspection, this is revealed to be a complex ring system of several concentric and variously shaded parts. The ring system of Saturn is unique among planets of the solar system.

Saturn exhibits a thick, outer envelope of atmosphere, with an estimated depth of 16,000 miles. This is assumed to overlie a comparatively thin mantle of ice which, in turn, surrounds a solid core of metallic rock. This great depth of atmosphere accounts for Saturn's low density. No perceptible cloud markings such as exhibited by Mars appear on the disk of Saturn, though cloud bands, parallel to the planet's equator, and occasional spots, do occur. Only the gaseous upper layers of atmosphere have ever been seen, and these obscure whatever true surface lies below. By instrumental analysis, the atmosphere of Saturn is found to be composed principally of methane and ammonia, with some hydrogen, also. Methane, here, bears a relatively greater proportion to ammonia than that found in the atmosphere of Jupiter.



COURTESY OF LICK OBSERVATORY

*SATURN AND ITS RINGS*

*The ring system lies in the plane of the planet's equator. The over-all diameter of the planet and its rings is 172,600 mi., with the inner edge of the ring system 6,000 mi. from the surface of the planet. The vertical thickness of the rings is less than 10 mi. The various concentric rings are composed of minute solid particles. The dark band of Cassini's division, 2,200 mi. wide, is a gap between adjacent rings. The shadow of the planet cast on the rings can be seen just above the planet's pole on the ring surface.*

This planet is over 800,000,000 mi. distant from the sun, even at its closest approach and, hence, receives very little light and heat. Measurements of the temperature at the surface show this to reach a maximum of −243° F.—sufficient to freeze portions of the gaseous atmosphere to a liquid or solid state. During its orbital revolution, Saturn reaches a minimum distance from the earth of about 745,000,000 miles. Its year is equal to 29½ terrestrial years. Saturn rotates in a period of slightly more than ten terrestrial hours, so that its day is less than half that on earth.

*Satellites of Saturn.* Nine satellites revolve around Saturn, the largest being Titan, 3,550 miles in diameter, the largest satellite in the solar system. These satellites revolve around the planet in periods ranging from a little less than one terrestrial day to 1½ years, depending upon their distances from the planet. The outermost satellite, Phoebe, revolves with a retrograde motion.

*Ring System.* The ring system of Saturn is composed of myriads of small particles, each revolving in a separate orbit about the planet. It is thought that these countless fine fragments may be the remains of yet another moon, which at some time in the remote astronomical past came within a zone known as *Roche's limit* (a theoretical distance equal to 2.45 times the radius of the planet). Conflicting gravitational forces acting from opposite portions of the sphere tore the original moon (moving into too-close proximity to the body of the planet) apart, distributing the resultant fragments along the present plane. The extremely fine particles composing the ring are in no way structurally connected, but held together in this formation by their common bonds of gravitational attraction, and by that of the planet. The fact that the inner edge of the ring system revolves more swiftly than the outer edge is observational proof of its discrete, small-particle nature.

**Uranus.** Uranus was the first of the outer planets not known to the ancient peoples, whose discovery was made possible by telescopic means. On the night of March 13, 1781, William Herschel, surveying the sky with a seven-inch reflecting telescope, came upon a greenish object showing a perceptible disk, for which no designation was given on existing star maps. Continuing to observe the object, he noted that it possessed a slow movement among the stars. It was at first assumed to be a comet, but later observation and calculation proved it to be of planetary nature. In accord with the tradition of naming the major planets after mythological deities, the name "Uranus," from the Greek god of the heavens, was adopted.

Uranus is a massive planet, 33,219 mi. in diameter, with a volume sufficient to contain 64 objects the size of the earth. It is usually just at, or below, the limit of naked-eye visibility. This planet requires 84 terrestrial years to revolve once around the sun. It is at an average distance of almost two billion miles from the sun, and its surface temperature reaches a maximum of only −300° F. It makes a complete rotation in 10 hrs., 42 min. The composition of its atmosphere is almost entirely methane.

*Satellites of Uranus.* Uranus has five satellites, the fifth and innermost being discovered as recently as 1948. Uranus presents a very curious anomaly in the otherwise orderly pattern of the solar system. The polar axis is tipped almost into the plane of the ecliptic, so that its satellites appear from the earth to revolve almost in a north-south plane. Due to this large inclination of the rotational axis of Uranus, the revolution of all of its satellites is apparently retrograde, although each actually revolves in the same direction as the planet's rotation.

**Neptune.** Neptune is very nearly 3 billion miles from the sun, and requires 165 terrestrial years to complete one revolution. In size and general aspects, Neptune forms a twin of Uranus. It has two satellites, the second being discovered in 1949. At its distance from the sun, Neptune receives only 1/900 of the light and heat received at the surface of the earth, and its surface temperature never rises above —330° F. Its atmosphere is predominantly methane. The period of rotation is approximately 15 hrs.

**Pluto.** Pluto requires 248 yrs. to complete one revolution. At an average distance of almost four billion miles from the sun, it receives only an insignificant fraction of the light and heat which fall upon the earth. It is obvious that Pluto is therefore eternally dark and frigidly cold. It shows little more than a starlike point of light in the largest telescopes. Pluto has an unusually elliptical orbit, at perihelion coming within 2.8 billion miles of the sun, within Neptune's mean distance, and at aphelion receding to a distance of 4.6 billion miles. It has the highest orbital inclination (17°) of any major planet. Its diameter has been measured as 3,600 mi., but its rotation period is unknown. The name Pluto was appropriately chosen, since Pluto was the Greek god of darkness.

## MINOR PLANETS

Minor planets are so-named because of their small dimensions in comparison with the major planets. Like the major planets, these small objects shine by reflected light from the sun, and each pursues a separate orbit around the sun. They are often called asteroids from their resemblance to star-like images in the telescope. Not many minor planets are large enough to show a perceptible disk. One (Vesta), at opposition, is barely visible to the unaided eye. The large gap between the orbits of Mars and Jupiter is the predominant zone of occurrence for the minor planets, which range from a fraction of a mile to several hundred miles in size. The inclinations, eccentricities, and orientations of their orbits vary widely. Minor planets would appear to be the fragments of a major planet that failed to materialize, or that somehow disintegrated, leaving thousands of small pieces in its stead. It has been estimated that fully 50,000 of these objects could be detected by systematic observation with the largest telescopes; yet, the volume of all the known asteroids put together is much less than that of the moon.

The first discovery of a minor planet (Ceres) was made by the astronomer Piazzi. Ceres was followed later by Pallas, Juno, and Vesta. These remained, for 40 years, the only asteroids known. But with the development of astronomical photography in the late nineteenth century, it was not long before hundreds of small planets were found.

Newly discovered asteroids are given a provisional year-designation until their separate identity is proved, and are then serially numbered. So numerous are the minor planets (over 1,500 are now well known), that it is difficult to keep up with all of their changing positions, although the orbit for each, and the disturbances due to the gravitational influence of the major planets, are determined as soon as possible.

Asteroid 433 Eros, which several times has returned to close proximity to earth and sun, has been used for establishing a more accurate value of the astronomical unit. Through the co-operation of world-wide observatories, a campaign for systematic observation of this minor planet has resulted in a very much more accurate determination of this basic value. In 1931, Eros came within 16,000,000 mi. of the earth. Eros exhibits remarkable variations in brightness within the course of a few hours, indicating a rapid rotation and unequal reflecting surfaces; likely, its shape is irregular.

Other minor planets making close approaches to the earth are Amor, Apollo, Adonis, and objects discovered recently by Wirtanen and Baade; and on Oct. 30, 1937, a rapidly moving asteroid approached the earth within a distance of approximately 475,000 miles. At maximum speed this object moved 5° per hour across the sky. The little planet was estimated to be about ¾ mi. in diameter; its calculated period was two years. So rapidly was the body moving, and so few observations were obtained, that existing orbit methods failed; the asteroid was lost; and has never been re-discovered. The object was known provisionally as the Reinmuth Object (1937 UB) after the name of its discoverer, Dr. Karl Reinmuth of Heidelberg. Later, in recognition of its fast movement, it was assigned the name Hermes, after the fleet-footed messenger of the Greek gods. Hermes has the record for the nearest approach to the earth. *See also* AURORA BOREALIS AND AURORA AUSTRALIS; COMETS; EARTH, THE; EPHEMERIS; KEPLER'S LAWS; METEORITES; METEORS; ORBIT; SOLAR MOTION; ZODIACAL LIGHT. F. J. Wo. and H. S. R.

**SOLAR TIME.** *See* TIME.

**SOLE,** *Solea solea,* a highly prized European food fish, of the family Soleidae. The sole is a flat fish with the color and eyes on the right side. The jaws and teeth are rather feeble. Other species of sole are found in temperate regions. It is commonly taken in shoal waters in the English Channel and Irish Sea; also it is found in the Mediterranean and the North Sea. It burrows into the sand and rarely moves except at night when it searches the bottom for food. When foraging, it touches the bottom with the side of the head which is supplied with small tactile filaments. Soles attain a length of 26 in. and weight of 9 lb. As in other flatfishes, the eyes of the sole are normally placed when newly hatched but the left eye migrates to the right side when the sole is 6 days old and less than one-half inch in length. In the American market, any one of several other flatfishes, such as flounder, plaice, fluke, and halibut, is frequently sold as sole. E. C. R.

**SOLEDAD PINE** or **TORREY PINE** [sɒ′ləd], a tree, *Pinus torreyana,* found native only in a restricted area near San Diego, California, and on islands off the Southern California coast. In the wild, it is a small, twisted tree, but under cultivation in good soil it will grow over 90 ft. high and may develop a spread of over 100 ft. The needles are in bundles of 5, grayish-green in color, and as long as 5 in. L. deF.

**SOLENODON** [soli′nodɒn], a genus of the mammalian order Insectivora. Two species, *S. paradoxus* and *S. cubanus,* from Haiti and Cuba, are the only representatives of the family. The latter may have become extinct. The animal is somewhat larger than a gray squirrel, has a prominent cylindrical snout, a long naked tail, and coarse fur. The foreclaws are stout and adapted for digging. The solenodon lives in rocky forests in mountainous areas. These animals are of interest to the zoologist because of the wide geographic separation which exists between them and their nearest relatives, the tenrecs of Madagascar. W. J. Ha.

**SOLENT** [so′lənt], a strait in the English Channel between Hampshire and the Isle of Wight. It terminates at the anchorage of Spithead and has a total length of 7 mi., and a width varying from 2 to 5 mi. Two bars projecting into the Solent at Southampton and at the western end are sites of the famous Tudor castles, Hurst and Calshot. The Isle of Wight causes a division of the tidal waters. S. Van V.

**SOLFEGGIO** [sɒlfɛ′jo], primarily a vocal exercise used either for training the voice or for practice in sight singing. The exercise may employ either syllables of solmization or plain vowels. Solfeggi originally used only solmization syllables, which also served as elementary instruction in interval recognition. Exercises on pure vowels were originally called *vocalizzi.* Vocal exercises without text for such uses have been composed by famous voice teachers and composers since the seventeenth century.

By extension, the term *solfeggio* has been applied to general courses in the rudiments of music, including the study of intervals, rhythm, scale structure, clefs, and notation. *See also* SOLMIZATION. F. C. C.

**SOLFERINO, BATTLE OF** [sɒlfəri′no], fought on June 24, 1859, the decisive engagement of the Austro-Sardinian War of 1859. After successive defeats administered to the Austrians by the French, command of the Austrian army was taken by Emperor Franz Josef. The Austrians had retired over the Mincio River after the Battle of Melegnano, though they still held a bridgehead over the river. Early on June 24, both armies planned to take the offensive and accidentally encountered each other. While the Emperor ordered his main body back over the Mincio, the French under MacMahon were advancing to occupy the left bank of the river. Contact was made at 8 A.M. on a limited front which soon stretched out to one of over ten miles. The French and Sardinians made slow headway against the Austrian line from Rebecco to Cavriana and thence north to Solferino, which was stormed and taken by the French guards. The fighting, with varying results, continued until late in the afternoon. About 4 P.M., in the midst of a thunderstorm, the Austrian commander ordered a retreat, leaving a covering force to protect the withdrawal. The Sardinians attacked in force and, lacking support or re-enforcement, the Austrians withdrew across the Mincio River, having lost 22,000 men, the Allies 17,000. On July 11, 1859, Napoleon III and Franz Josef signed the peace of Villafranca and hostilities ended. M. K.

**SOLIDS AND LIQUIDS, THEORY OF.** There are three easily distinguishable types of aggregation in which the atoms of matter may exist: the gaseous, liquid, and solid states of matter. Gases are characterized by the properties of large compressibility and small density, whereas solids and liquids possess small compressibility and relatively large density. Under normal conditions of temperature and pressure, the mass of a unit volume of a gas is of the order of a thousandth of that of a typical solid or liquid. The great compressibility of a gas results in the property it possesses of filling completely a container in which it is confined. This property is sometimes referred to by stating that a gas has no definite volume. A solid has a volume which changes little with change in pressure, and also a definite form. Liquids are like gases in that they cannot support shearing stresses and adapt their form to that of the containing vessel. Liquids are similar to solids, however, because of their small compressibility, their volume depending to only a slight extent on external conditions.

The differences in the physical properties of gases and solids can be understood if it is assumed that the atoms are separated by much larger distances in gases than they are in solids or liquids. Since there are relatively few atoms in a unit volume of a gas, the density is small; and since the atoms are separated by relatively large distances, the interatomic forces

are weak and it is easy to change the interatomic spacing. The theory of gases is much simpler than that of solids and liquids, because the atoms of a gas are widely separated and the forces acting between them are weak. An adequate theory of gases can be constructed by ignoring the interatomic forces completely and considering only the motion of the atoms. This procedure cannot be adopted in developing a theory of solids and liquids, in which the interatomic forces must be explicitly considered, because the atoms are close together and the forces between them are very powerful. Since there are several types of interatomic forces, the properties of solids and liquids show more variety than those of gases. The properties of mercury and argon, for example, are very similar when these substances are in the gaseous state but quite different when they are in the liquid and solid states.

## THE SOLID STATE

Solids are commonly classified according to the type of attractive force which is predominantly responsible for the cohesion of the atoms. In the following discussion of attractive forces this convenient classification of solids into ionic crystals, valence crystals, metals, and molecular crystals is followed.

**Ionic Crystals.** It has been determined that an electron can be rather easily removed from a sodium atom and that an atom of chlorine tends to add an electron to itself. By these means, the atoms assume the stable configurations of the rare-gas atoms neon and argon, respectively. The process of transfer of an electron from a sodium atom to a chlorine atom will take place if the atoms come into contact with each other. After the transfer of the electron, each atom is electrically charged, and is then referred to as an ion. The positively charged sodium ion and the negatively charged chlorine ion will attract each other with the well-known electrostatic Coulomb force, which is directly proportional to the product of the charges of the ions and inversely proportional to the square of the distance between them. Under the influence of this attractive force, the ions will approach each other until their closed shells begin to interpenetrate. The closed-shell repulsive force will then suddenly increase, and the two atoms will remain at the equilibrium distance of separation at which the attractive Coulomb force is just balanced by the repulsive force.

The same forces that act on one ion of sodium and one of chlorine also affect a mixture of large and equal numbers of ions of each kind. Each sodium ion will tend to surround itself with chlorine ions, and each chlorine ion will tend to surround itself with sodium ions. The sodium ions will repel each other, as will the chlorine ions also, since the Coulomb force of electrostatics is one of repulsion between ions of like sign of charge. The result of the interplay of forces between the ions is a coalescence of the ions to form a crystal. The technique of X-ray diffraction reveals crystal structures such as this and allows the interatomic distances to be measured with great precision. There is a definite symmetry to the structure—that of a cubic lattice. Each sodium ion has six chlorine ions as its nearest neighbors, and each chlorine ion has six sodium ions for neighbors. Structures of this or very similar type are characteristic of ionic crystals where the attractive force is nondirectional and the ions are spherically symmetric.

Since the formation of ions by transfer of electrons from atoms of one type to atoms of another type is necessary if the Coulomb force of attraction is to exist, ionic crystals are formed by the combination of elements from opposite ends of the periodic table of the chemical elements. One of the elements must be electropositive in character, each of its atoms having lost one or more electrons to the atoms of the other element, which must be electronegative in character. The most typical ionic crystals are therefore alkali halide compounds, such as lithium fluoride, sodium chloride, and potassium bromide. Also strongly ionic in character are the oxides of the alkaline-earth metals, such as calcium oxide and magnesium oxide.

Since ionic crystals are formed of positively and negatively charged ions, if the resulting crystal is to be electrically neutral, there must be equal numbers of each type of ion present if the ions are equally charged. In an ionic solid such as magnesium fluoride, the number of fluorine ions must be just double the number of magnesium ions, since each magnesium atom has lost two electrons and each fluorine atom has gained one. Therefore ionic crystals obey the chemical laws of definite composition and of combining weights very exactly.

**Valence Crystals.** The salient features of the homopolar bond which provides the attractive force binding atoms together in valence crystals can be displayed by considering the behavior of two hydrogen atoms which are interacting with each other.

As two hydrogen atoms approach each other it cannot be expected that there will be a permanent transfer of electrical charge from one to the other, because they are identical in their structure. Yet, each will attempt to add an electron to its structure so that it may achieve the stability of the helium atom with its closed shell of two electrons. The compromise reached by the two atoms consists of a sharing of their electrons with each other. The two electrons which are shared between the atoms spend the major fraction of the time between the nuclei of the atoms. In order that this electron-pair bond may be formed, an important condition must be met. An electron behaves like a small magnet, and the axes of the magnetic moments of the two electrons must point in opposite directions if they are to form a homopolar bond. An electron's property of behaving like a magnet is usually referred to as a result of electron spin. The condition of antiparallel spins, which is demanded by the fundamental principles of quantum mechanics if the electron-pair bond is to form, gives this bond the property of saturation. Two hydrogen atoms may unite to form a molecule by using their electrons to form an electron-pair bond. A third hydrogen atom cannot be added to the diatomic molecule, however, because of necessity the spin of its electron will be parallel to the spin of one of the two electrons in the molecule. For this reason, hydrogen atoms cannot make use of the valence or electron-pair bond to form a crystal composed of many hydrogen atoms. As an example of a crystal in which the atoms are held together by valence forces it is necessary to turn to the diamond.

The carbon atom has the property of possessing four electrons in an unfilled shell. By adding four more electrons to its structure, it is able to imitate the stable structure of neon. In the diamond crystal, each carbon atom shares its four electrons with four other carbon atoms, thereby forming four electron-pair bonds with four other atoms. In this manner an indefinitely large array of carbon atoms may be joined together to form a crystal.

The magnitude of the attractive force between atoms which have formed an electron-pair bond is large. As a result, the work that must be performed to separate the atoms of a valence crystal from each other is large. The heats of sublimation of typical crystals as shown in the table are a direct measure of the work necessary to separate the atoms or ions of the crystal from each other. It will be noticed that the values for valence crystals are of the same order of magnitude as those

for ionic crystals. Another result of the strength of the valence bond is that the melting points of valence crystals are high, even higher than those of ionic crystals.

HEATS OF SUBLIMATION OF SOLIDS
*(Kilogram-Calories per Mol)*

| *Ionic Crystals* | | *Valence Crystals* | | *Metals* | | *Molecular Crystals* | |
|---|---|---|---|---|---|---|---|
| NaCl | 153.1 | Diamond | 170. | Na | 25.9 | Helium | 0.052 |
| KCl | 153.1 | Boron | 115. | Cu | 81.2 | Neon | 0.52 |
| NaBr | 139.5 | Silicon | 85. | Ca | 47.8 | Argon | 1.77 |
| KBr | 140.8 | Germanium | 85. | Zn | 27.4 | Hydrogen | 2.44 |
| NaI | 120.8 | SiC | 283. | Al | 55. | Oxygen | 1.74 |
| KI | 124.3 | $SiO_2$ | 405.7 | Fe | 94. | Nitrogen | 1.50 |
| | | | | Pt | 127. | | |

**Metals.** The majority of the chemical elements exist in the solid state in the form known as metals. The characteristic feature of metals is their electrical conductivity. The attractive force which binds the atoms together in metals is very similar in nature to that existing between atoms in valence crystals. There are certain peculiarities of the homopolar bond between atoms in metals which give to metals quite different properties than those of valence crystals. The cause of the special character of the homopolar bond in metals lies in the fact that the atoms which form metal crystals are always electropositive, tending to lose electrons and form rare-gas structures of closed shells. When these atoms unite by forming homopolar bonds with each other, the shared electrons are not localized as they are in the bonds formed between atoms in valence crystals. It cannot be said that any two of the valence electrons are co-operating to bind together a particular pair of atoms. The electrons forming the homopolar bonds are free to roam the interior of the metal—a condition which results from the fact that these electrons were very weakly bound to individual atoms before the formation of the homopolar bonds.

An immediate consequence of the freedom of motion of the valence electrons in metals is the large electrical conductivity. A second consequence is that the homopolar bond in metals is not directional in character, and the crystal structures thus tend to be simple and similar to those of ionic crystals where the Coulomb force is also nondirectional. Unlike ionic compounds, the metals have little tendency to obey the law of definite composition, because the atoms are uncharged. In general, two metallic elements can be alloyed in any proportions and do not form a compound of specific composition. When they do form such a compound, it is because one element is sufficiently more electropositive than the other that there is a permanent transfer of charge between the atoms. Under these circumstances, the attractive force between the atoms is partially ionic in origin. The rather small heats of sublimation of typical metals shown in the preceding table indicate that the homopolar bond in metals is considerably weaker than it is in valence crystals.

**Molecular Crystals.** The atoms of rare gases such as helium and neon are unique in that the number of electrons possessed by each is such as to allow the formation of the most stable possible atomic structure. One would not expect these atoms to form homopolar bonds with each other or with other atoms. Neither would the formation of ions by the gain or loss of electrons be expected to occur, since this process would lead to the formation of less stable structures. At low temperatures the rare gases do condense, however, to form liquids and, except in the case of helium, solids.

The explanation of the attractive forces between atoms of the rare gas type is as follows: Although the electrons are arranged in closed shells having spherical symmetry on the average, the motion of the electrons leads to small fluctuating deviations from complete spherical symmetry. These small fluctuations from a spherically symmetric distribution of the electronic charge give the atom a fluctuating electric dipole moment. Another atom exposed to the rapidly varying dipole field of the first atom will have the motion of its electrons slightly altered. The dipole moment of this second atom tends to change in synchronism with that of the first atom, and the directions of the dipole moments are such that there is on the average a net force attracting the atoms to each other. It can be easily shown that this weak dipole-dipole or van der Waals' force varies as the inverse seventh power of the interatomic separation.

Many molecules, of which the hydrogen molecule is an example, condense to form liquids and solids because of these dipole-dipole forces between them. That this binding force is very weak is shown by the low melting and boiling points of these substances and their extremely small heats of sublimation. Among the vast class of organic compounds, the forces binding the atoms together to form molecules are predominantly homopolar in type, but the complex molecules are bound together to form solids and liquids by the relatively weak van der Waals' forces. The result is that most organic compounds have low melting and boiling points and small heats of sublimation.

### THERMAL MOTION OF THE ATOMS

A theory of a solid as an assemblage of atoms rigidly bound together by the action of attractive and repulsive forces is an oversimplified static representation. A more correct model of a solid is a dynamic one in which the atoms are in motion, vibrating back and forth about equilibrium positions. This picture follows naturally from the theory that heat is a form of energy. A solid or liquid possesses energy because of the kinetic and potential energy of the individual atoms. Raising the temperature of a solid by adding heat to it increases its internal energy by increasing the amplitude of vibration of the atoms. The frequency of the atomic vibrations is determined by the forces which bind the atoms together.

### ELECTRICAL CONDUCTIVITY

**Measurement of Conductivity.** A most striking property of solids is that they are divided into two distinct classes with respect to their ability to conduct an electric current. In one class are the metals with very large conductivities, of the order of $10^5$/ohm-cm. In the second class are the ionic, valence, and molecular crystals with very small conductivities, of the order of $10^{-12}$/ohm-cm. There are a relatively few substances with intermediate conductivities known as semiconductors. A great deal of evidence indicates that these substances owe their ability to conduct either to impurities or to imperfections in structure.

**Nonconducting Crystals (Insulators).** Although the origin of the conductivity of metals is clear, it is much more difficult to understand why the other classes of crystals do not conduct. The fundamental difference between insulators and metals is that in insulators the number of "free" electrons that can be accelerated by an electric field is vanishingly small, whereas in metals this number is approximately the same as the number of valence electrons. In ionic, valence, and molecular crystals, the grouping of electronic energy levels into bands and the total number of electrons are such as to leave the bands either completely filled or completely empty of electrons. As a result, the electrons cannot gain energy from an electric field.

### THE LIQUID STATE

The theory of the liquid state is considerably more difficult than that of the solid state, fundamentally because in discussing liquids it is not possible to separate the investigation of the thermal motion of the atoms from the study of the static structure imposed by the interatomic forces. As a result the theory of liquids is still incomplete.

**Effect of Temperature.** As the temperature of a solid is increased, there occurs at the melting point a discontinuous change in its properties. The density decreases by several per cent, and the liquid is unable to sustain shearing forces. It is clear that the atoms are, on the average, farther apart, and that the interatomic forces are weaker than in the solid. Examination of the liquid by the technique of X-ray diffraction shows that not only has the interatomic spacing increased but that the regular arrangement of atoms on a lattice has disappeared. It is true that in the vicinity of any given atom there is a semblance of the order present in a solid, but all trace of order disappears if a region containing many atoms is observed. The distance between pairs of atoms is different from pair to pair, and changes rapidly with the time for a given pair. Because of the weakening of the interatomic forces the amplitude of vibration of the atoms is greater than in the solid. This condition, coupled with the fact that there are many vacancies present, gives the atoms much greater mobility than in a solid, and they change positions relatively rapidly. The higher the temperature of the liquid, the less does the structure resemble that of a crystal and the more does it appear like that of a gas in which all trace of molecular order has disappeared.

**Supercooling.** Certain liquids can be supercooled, that is, they can be cooled to a temperature below their melting point, where the thermal motion of the atoms is of no more importance than in crystals, and yet they preserve the irregular structure of a liquid phase. Such supercooled liquids are not in equilibrium; eventually the thermal motion of the atoms rearranges the structure and a crystal lattice is formed. Ordinary glass is the most common and important example of a supercooled liquid. F. S. and R. J. M.

**SOLINGEN** [zo'lɪŋən], an industrial city in central western Germany, about 17 mi. northeast of Köln (Cologne), in the state (*Land*) of North Rhine-Westphalia, formerly a part of the Prussian Rhine Province. It lies on the Wupper River, on a height overlooking a bend in the river. Its industries reputedly originated with artisans brought from Damascus by Adolph IV of Berg during the Crusades. It was chartered in 1374 and was a member of the Hanseatic League. Lying on the southern edge of the great Ruhr industrial area, Solingen, particularly its aircraft industries, was very heavily bombed in World War II. After the war it was included in the British zone of occupation. Famed since the Middle Ages for its cutlery and hardware, its factories produce surgical instruments, machine tools, knives, scissors, saws, files, razors, bicycles, and other metal wares. Pop. 1953, 157,900. C. C. H.

**SOLIPSISM** [sɒ'lɪpsɪzəm], the philosophical theory that knowledge is confined to the states of the knower's own self. If a thinker holds, as Hume did, that everything experienced through the senses, such as color and sound, hardness and shape, consists merely of sensations in the experiencing mind, and that ideas are nothing but copies of these sensations, the step is an easy one to the two conclusions that nothing beyond these mental states can be known with certainty, and that it is uncertain whether anything beyond them exists to be known. Hume regarded both conclusions as logically inevitable, though he admitted that in practice he neither did nor could take them seriously. Solipsism is the farthest point to which philosophic skepticism has been carried. *See also* IDEALISM; SKEPTICISM; SUBJECTIVISM. B. B.

**SOLITAIRE,** any one of a number of species of medium-sized New World thrushes combined in the genus *Myadestes.* They inhabit the mountains of western North America, Central and South America, and some of the West Indian islands. Their plumage is usually quiet patterns of grays, browns, and white; that of the only species found in the United States, *M. townsendi,* is mainly a brownish gray bird, about 8 in. long, with touches of white in the wings and tail. As a group they are famous for their songs, which are rendered in unusually strong, clear voices. The popular name, first given them by early French travelers, is derived from their shyness and their custom of living in wild regions at a distance from human habitation. H. G. De.

**SOLITAIRE.** *See* CARD GAMES.

**SOLMIZATION** [sɒ'lmɪze'shən], a musical system designating scale tones by the use of syllables instead of the usual letter names. The system most widely used today, based on the eleventh century Guidonian hexachord, consists of the following syllables: *do, re, mi, fa, sol, la, si,* or (*ti*). The two modern ways of applying them are called the "fixed *do*" and the "movable *do.*" The Continental "fixed *do*" invariably applies the above syllables to the tones of the C major scale, and the syllables of any other scale are reckoned from this norm. The "movable *do*" series, used almost exclusively in Great Britain and the United States, applies to any major scale so that each syllable takes on a particular tonal function, i. e., *do* is always the first tone, *sol* is always the fifth tone, and so forth. The "movable *do*" has wider and more practical usage, especially in teaching rudimentary musical subjects such as scales, various clefs and intervals. Use of the solmization principle is very old. Ancient Greek, Chinese, and Hindu systems are among those that antedate the eleventh century Guidonian method. In the last five hundred years several other systems have been introduced, but none has become permanently important. One modern substitute which uses numbers instead of syllables has been introduced with some success by the Eastman School of Music in Rochester, N. Y. *See also* GUIDO D' AREZZO. F. C. C.

**SOLO.** *See* SOERAKARTA, SURAKARTA, or SOLO.

**SOLO** (*It.* "alone"), a musical composition to be executed by one performer either with or without accompaniment. In orchestral and band music, passages marked "solo" are meant to be given special prominence as opposed to routine passages which must be carefully blended into the ensemble. In concertos, a distinction is made between solo passages, in which the orchestra is subordinate to the soloist, and tutti passages in which the orchestra alone is heard. W. Li.

**SOLOGUB, FYODOR** [sʌlʌgu'p], pseudonym of Fyodor Kuzmich Teternikov (1863-1927), Russian poet, novelist and dramatist. Sologub was born in St. Petersburg (Leningrad), the son of a tailor and of a house servant. After the early death of his father, he was brought up in a cultured family where his mother was employed. After graduating from a teachers' college in 1882, Sologub taught school for seven years in several provincial towns where his cheerless experi-

ences, before he was transferred to St. Petersburg, provided the substance for his later novels, *Heavy Dreams* (1896) and *The Little Demon* (1905). *The Little Demon,* written between 1892 and 1902, is his prose masterpiece and one of the principal works in the literature of Russian symbolism. He started publishing poetry in 1884, and collections of his poems appeared in 1896, 1904, 1906, and 1908. In 1908 he published a collection of translations from Paul Verlaine. Sologub's talent reached its highest expression in his somewhat difficult but interesting and highly suggestive poetry. In 1907, when he retired on a pension after twenty-five years of teaching, he was at the pinnacle of his fame. He died in St. Petersburg on Dec. 6, 1927.

Sologub had a most unusual attitude toward life and death, for he rejected the visible world created by God as something inexpressibly vulgar and looked for an ideal world of beauty in death ruled by Satan. Much of his poetry, perfect in form, is permeated with extreme eroticism. He also wrote numerous short stories, in which his tragic pictures of unhappy children are disturbingly effective. During the symbolist phase of the Moscow Art Theatre and of the Russian stage generally, he wrote a number of symbolist dramas, of which the most striking are *The Gift of the Wise Bees* (1906) and *The Triumph of Death* (1907), the latter based on the old French legend of Bertha of the Big Foot, mother of Charlemagne. Sologub's complete works appeared in 12 volumes in 1909-1912 and in 20 volumes in 1912-1914. L. I. St.

**SOLOLÁ** [sololɑ′], the capital of the department of the same name in Guatemala. The city is situated at an altitude of 7,100 ft. near Lake Atitlán, about 45 mi. northwest of Guatemala City. Most of the inhabitants of the city are Cakchikel Indians, who once had the city as their capital. Sololá's market is a trade center for the agricultural products of the surrounding region. Earthquakes are frequent, and in 1902 the town was almost totally destroyed by one, but it has since been rebuilt. The department of Sololá comprises an area of approximately 410 sq. mi. Pop. 1940, 16,233. S. G. I.

**SOLO MAN.** *See* Evolution of Man.

**SOLOMON,** in the Old Testament, the son of King David and the third and last king of a united Israel. He reigned for forty years (c. 977-c. 937 B.C.). The name Jedidiah, which means "beloved of God," was given to him at birth by the prophet Nathan (II Sam. xii:25); the name Solomon (Heb. *Shlomoh,* "peace") was his throne name and symbolizes the peaceful nature of his reign.

Solomon was one of the four sons of David and Bathsheba (I Chron. iii:5; xiv:4). Through the intervention of Bathsheba and Nathan, David appointed him his successor in preference to his son Adonijah. There is a Jewish and Arabic tradition that Solomon was only twelve years old when he began to reign; it is more probable that he was about twenty. In order to secure his throne, Solomon struck at those he considered his or his father's enemies. He had Joab, Shimei, and Adonijah put to death, and he replaced the high priest who favored Adonijah.

Solomon established himself as a strong and influential ruler. By building a number of fortifications, and entering into alliances with Tyre and Egypt, he strengthened his kingdom politically; by making commercial treaties with neighboring countries, sending out fleets to distant countries, and establishing smelting works in Ezion-Geber, he strengthened it commercially; and by dividing the country into districts, which were governed by his appointees, he unified its inner administration. He built a beautiful palace, developed an elaborate and extravagant court life, and maintained a large harem. He married the daughter of Pharaoh, receiving the city of Gezer as a dowry. His primary achievement was the building of the Temple in Jerusalem which centralized religious worship and became the historic symbol of Jewish religious glory and splendor. Solomon's activities, however,

CULVER SERVICE

*THE JUDGMENT OF SOLOMON*

FROM A PAINTING BY RAPHAEL

placed a great financial burden on the people, engendering a discontent which led to the disruption of the kingdom after his death.

Very early in his reign, Solomon gained a reputation as a wise man and ruler. His wisdom, which has become proverbial, is illustrated in the Bible by his judgment in the case of the two women who claimed the same child as their own (I Kings iii:16-28), and by the account of the visit of the Queen of Sheba, who "came to prove him with hard questions" (I Kings x:1-10). A large body of legends and traditions has developed around his personality. He is supposed to have mastered the language of animals and to have been able to communicate with and hold in his sway the demons and their chief, Asmodeus. The Book of Proverbs, the Song of Songs, and the Book of Ecclesiastes are traditionally attributed to him. M. A. G.

**SOLOMON ISLANDS,** a double row of large, mountainous, essentially volcanic islands with adjacent smaller islands and islets in the South Pacific Ocean east of New Guinea, 3° to 12° S. lat., 154° to 163° E. long., extending over a region 600 mi. long and 1,000 mi. wide. Total area is about 16,310 sq. mi. Peaks of the Crown Prince Range rise to more than 10,000 ft. (Mount Balbi), on Bougainville, the largest island of the group, 110 mi. long, 20 to 35 mi. wide; and over 8,000 ft. (Mount Lammas), on Guadalcanal,

the second largest. Other islands are Malaita, New Georgia, San Cristobal, Santa Isabel, Choiseul, Florida, Vella Lavella, Kolombangara, Buka, Shortland, Rendova, Vanguna, Rennell, and Tulagi. The group was discovered about 1567 by a Spaniard, Alvaro de Mendaña, but not until 1875 were traders living on the islands.

The climate is hot and damp, the flora luxuriant, and much of the animal life related to that in New Guinea. Most of the natives are Melanesians with a few Polynesians. In 1940 there were about 50,000 acres of coconut plantations in the group, and copra was the leading export. Other products are kauri wood, ivory nuts, trochus shell yielding mother-of-pearl, and smoked and dried trepang (*bèche-de-mer,* sea cucumber), prized as a delicacy by the Chinese. During World War II the group was the scene of large-scale naval, air, and land battles between Japanese and Allied forces, the great land battles being fought chiefly on Guadalcanal, the New Georgia group, and Bougainville.

**Political Divisions.** *British Solomon Islands Protectorate.* The British Solomon Islands Protectorate lies in the approximate area enclosed by 5° to 12° 30′ S. lat. and 155° 30′ to 169° 45′ E. long. Guadalcanal, Malaita, San Cristobal, and New Georgia came under British "protection" in 1893, followed in 1898 and 1899 by Santa Isabel, Choiseul, Shortland, Mono (or Treasury), Vella Lavella, Ronongo, Gizo, Rendova, Russell, Florida, Rennell, and smaller islands including the Lord Howe group or Ongtong Java, the Santa Cruz Islands, Ticopia and Mitre islands, and the Duff, or Wilson, group. Guadalcanal, the largest island, has an area of 2,500 sq. mi. Malaita, with 40,000 inhabitants, is the most populous. The total area of the protectorate is about 12,400 sq. mi., with a population, mostly native, of 94,105 in 1931. The resident commissioner's headquarters are on Guadalcanal. There is an advising commission but no representative body.

*Australian Mandate.* Since 1920, Bougainville, Buka, and adjacent islands, including Nissan, Kilinailau, Tauu (Mortlock), and Nukumanu (Tasman) islands, all formerly included in German New Guinea, have formed part of the Australian mandated territory of New Guinea. Bougainville, the largest island, has an area of 3,880 sq. mi. In 1931 its native population, including that of near-by Buka (190 sq. mi.) was 50,206. The other islands are about 30 sq. mi. in area, with a small population. R. G. B.

**SOLOMON'S-SEAL,** a genus, *Polygonatum,* of about 30 perennial herbs of the lily family. These plants are found in north temperate regions; two are common in the woods of eastern and central North America. They have thick horizontal rootstocks, marked with seal-like scars where the old stems have disappeared. The unbranched leafy stems are erect or arching, and bear small, greenish or pinkish flowers drooping from the axils of the sessile leaves on slender stalks. The small Solomon's-seal, *P. biflorum,* grows about 3 ft. high, and the great Solomon's-seal, *P. commutatum,* sometimes reaches a height of 8 ft. J. C. Wis.

**SOLOMON'S-SEAL, FALSE,** a small genus, *Smilacina,* of perennial woodland herbs of the lily family found in the Northern Hemisphere. *Smilacina racemosa* sends up in spring from a thickened rootstock a stem about 2 to 3 ft. high with alternate leaves, terminating in a panicle of tiny white flowers. A cluster of dull red translucent berries develops during the summer. It is common in North America, and both the starchy rootstock and the berries were used for food by the North American Indians. J. C. Wis.

**SOLON** [so′lɒn; so′lən] (c. 640-c. 559 B.C.), Athenian statesman, was born in Athens about 640 B.C. In order to avert civil war the Athenians in 594 B.C. elected Solon as archon and empowered him to institute political and economic reforms. Solon first freed those who had been enslaved for debt, and enacted a law which forbade loans in which the loss of personal freedom was the penalty for default. Other economic reforms encouraged olive culture in Attica and stimulated the growth of Athenian trade and industry. In the political field Solon set up a timocratic government at Athens by grading political eligibility and activity in terms of income. All citizens were arranged in classes according to their wealth. The *hippeis* or knights, the wealthiest class, were eligible to sit in the council and to hold the highest magistracies. The *zeugitae* or middle class could hold lesser offices and be members of the council, whereas the poorer citizens or *thetes* could participate only in the assembly. The council, better known as the Council of the Four Hundred, was another of Solon's innovations; its members were annually elected by the four Athenian tribes, one hundred persons from each tribe. The council advised and supervised the magistrates, and drafted legislation to be presented to the assembly for enactment. Solon also established a court of appeal, the Heliaëa. It was actually the assembly, with a quorum of six thousand, sitting as a court to hear appeals from sentences involving penalties of death, banishment, or heavy fines. Solon died about 559 B.C. T. B. J.

**SOLOTHURN** [zo′loturn], the name of a canton and its capital in northwestern Switzerland.

**The Canton.** With an area of 306 sq. mi., and an irregular shape, the canton consists of the Aare Valley, but an extension crosses the Jura Mountains to the north, and one isolated section reaches the French-Swiss frontier. The canton is enclosed by Bern on the south and west, Basel on the north,

SOLOMON'S-SEAL, POLYGONATUM BIFLORUM
FROM WILLIAM WOODVILLE'S *MEDICAL BOTANY*

and Aargau on the east. Most of the population is concentrated in the area of plain along the Aare Valley. North of the city of Solothurn rises the Weissenstein section of the Jura, with the highest point, Hasenmatt, 4,751 ft. The Aare River receives the Wigger at Aarburg and the Dunneran from Jura at Olten. The River Birs flows in the northern part of the canton. Pop. 1953, 178,600.

**The City.** The capital city is situated 19 mi. north-northeast of the city of Bern, on the Aare River at the foot of the Weissenstein Range of the Jura, between Biel and Olten. Industrial products are jewelry, shoes, cotton, motor parts, and cement. Pop. 1953, 17,500.

The city of Solothurn grew up around the house of secular canons founded in the tenth century by Queen Bertha, wife of King Rudolph II of Burgundy, in honor of Saint Ursus and Saint Victor. It became a free city of the Holy Roman Empire in 1218. During the fourteenth century the government of the town was assumed by the guilds. Solothurn was admitted to the Swiss Confederation along with Fribourg at the Diet of Stans in 1481. In 1529 most of the communes in Solothurn went over to the Reformed Church. S. Van V.

**SOLOVYOV, VLADIMIR SERGEYEVICH** [sʌlʌ-vyɔ′f] (1853-1900), Russian philosopher, mystic, poet, and publicist, was born in Moscow on Jan. 16, 1853. His father, Sergei Mikhailovich, son of an orthodox priest, was a great Russian historian. His mother, Poliksevna Vladimirova *née* Romanova, came from the same family as the Ukrainian philosopher Gregory Savich Skovroda (1722-1794). Solovyov was graduated from the Fifth Moscow Gymnasium with a gold medal, studied physics and mathematics for two years at Moscow University, and passed on to history and philosophy; during that period he took a course at the Moscow Theological Academy. In 1873 he was graduated from the University and in 1874 prepared the *Crises of Western Philosophy* as his Master's thesis. He received an appointment as Fellow of the University of Moscow and visited England, France, Italy, and Egypt. In 1880 he presented the *Criticism of Abstract Principles* as the dissertation for his Doctorate in Philosophy. He then resigned his position in Moscow University and went to St. Petersburg, starting to give public lectures and write his works. Solovyov was helpless and impractical; everything he had went to the poor; he had no permanent residence and died as a guest in the house of his close friend, Prince Troubetzkoy, near Moscow on July 31, 1900.

The aim of Solovyov's philosophy is to "justify the faith of the Fathers," to justify faith by reason. Theocracy under a universal church, he said, is the purpose of history. Eventually, however, he saw that the Kingdom of God could be fully actualized only after the apocalyptic transfiguration of humanity and of the universe, but he felt that the process of ascent from "Man-Beast" to "God-Man" must go on. The doctrine on "Sophia," "Man-Godhood," the deification of humanity, is the legacy of Solovyov to Russian theology, and it influenced the prose works of Sergius Boulgakov, Nikolai Berdyayev, and the poetry of Alexander Blok and Andrei Belii. Solovyov's most important technical contribution to philosophy is his concept of the "Absolute" as the subject of Being, in his work *Criticism of Abstract Principles*. His poems show an absorbing interest in "eternal Beauty," with an almost religious expectation of its realization. Solovyov's most important works are: *Crisis of Western Philosophy* (1874), *Philosophical Foundations of Integral Knowledge* (1877), *Lectures on God-Manhood* (1878), *Criticism of Abstract Principles* (1880), *Spiritual Foundation of Life* (1882), *The History and the Future of Theocracy* (1886), *Justification of Good and the Three Dialogues—Including Narration on Anti-Christ* (1896-1900). P. P. Z.

**SOLSTICES** [sɒ′lstɪsəz], points on the ecliptic, midway between the two equinoxes. The summer solstice for the northern hemisphere is the point at celestial longitude 90° (right ascension $6^h$) where the sun enters the sign of Cancer and attains its greatest northern declination (+23½°). At this point it is the beginning of summer in the northern hemisphere. The same point and time become the winter solstice for the southern hemisphere. The point is at the border of the constellations Gemini and Taurus and is reached on the average on June 21. The winter solstice for the northern hemisphere is the point at longitude 270° (right ascension $18^h$) where the sun enters the sign of Capricorn and attains its greatest southern declination (−23½°). At this moment it is the beginning of winter in the northern hemisphere. The same point and time become the summer solstice for the southern hemisphere. The point is in the western part of the constellation Sagittarius and is reached on the average on December 22. The term solstice is thus applied chiefly to the locations on the celestial sphere but also to the moments of time. H. S. R.

**SOLUTION, CHEMICAL,** a homogeneous mixture of two or more substances, there being only one phase, which may be either gaseous, liquid, or solid. The molecules of each component of the solution are completely and uniformly dispersed among those of the others. The component present in largest amount in a solution is called the solvent, whereas the one (or ones) present in smaller proportion is referred to as the solute (or solutes). When a given quantity of solvent has dissolved as much of a particular solute as it possibly can at a specified temperature and pressure, the solution is said to be saturated.

## SOLUBILITY

The concentration of a solution, expressed in suitable terms, is referred to as the solubility of the solute in the given solvent under the specified conditions. The solubility of one substance in another is usually affected by the temperature and, particularly when a gas dissolves in a liquid, by the pressure. The process of solution is almost invariably accompanied by a heat change, referred to as the heat of solution; this may be positive or negative for different solvents and solutes, and may vary to some extent with the concentration of the solution.

**Gases.** Provided there is no chemical interaction, gases can be mixed with one another in all proportions. Consequently, for a solution of one gas in another there is no solubility limit and the question of saturation does not arise. However, when a gas is dissolved in a liquid there is a definite maximum solubility, i.e., a saturated solution, at any given temperature and pressure. The solubilities of a series of gases in a particular liquid are, in general, related to their ease of liquefaction. The more readily liquefiable gases, e.g., ammonia, sulphur dioxide, and hydrogen chloride, are usually more soluble than those, e.g., oxygen, hydrogen, and helium, which are difficult to liquefy (*see* Table 1). Chemical interaction between the gas and the solvent, such as probably occurs when ammonia and hydrogen chloride are dissolved in water, results in an increased solubility. Although the solubility of a particular gas varies with the nature of the solvent, the order of increasing solubility of a number of gases is approximately the same in different solvents.

The solubility of a gas in a liquid is best expressed in terms

Table 1. Solubilities of Certain Gases
*(Volume in liters absorbed in 1 liter of water)*

| *Name of Gas* | *At 0° C. and 760 mm.* | *At 20° C. and 760 mm.* |
|---|---|---|
| Ammonia | 1,300 | 710 |
| Carbon dioxide | 1.71 | 0.878 |
| Chlorine | .... | 2.26 |
| Hydrogen | 0.0215 | 0.0184 |
| Hydrogen chloride | 506 | 442 |
| Nitrogen | 0.0235 | 0.0164 |
| Oxygen | 0.049 | 0.031 |
| Sulphur dioxide | 79.789 | 39.374 |

of the mole fraction (*see* Concentration, *below*), but since the values are often very small they are not convenient. An alternative method makes use of the absorption coefficient discovered by R. Bunsen in 1857, which is the volume of gas, reduced to 0° C. and 1 atmosphere pressure, dissolved at saturation by unit volume of solvent at the temperature of the experiment and under a pressure of one atm. of the gas. Since a gram-molecular weight of any gas occupies approximately 22.4 liters at 0° C. and 1 atm., it follows that if the absorption coefficient is divided by 22.4, the result is the solubility of the gas, at the experimental temperature and 1 atm., expressed in moles per liter of solvent or, approximately, of the solution.

When a gas dissolves in a liquid there is usually a liberation of heat; hence, from the Le Châtelier principle, increase of temperature should result in a decrease of solubility. This is generally the case, the effect being more marked for the very soluble gases. The "flat" taste of boiled or distilled water is attributed to the fact that the dissolved air is expelled upon boiling, its solubility being very small at the higher temperature.

Increase of pressure results in an increased solubility of a gas. According to Henry's law, which is obeyed well by the sparingly soluble gases but only approximately by the very soluble ones, the weight of gas that can be dissolved by a given volume of liquid, at constant temperature, is proportional to the pressure of the gas. This behavior is utilized in the preparation of artificially carbonated beverages. Carbon dioxide gas is dissolved in the liquid at a pressure of 3 to 4 atm., so that the weight of gas dissolved is three to four times that at 1 atm. pressure. When the bottle is opened, the pressure is decreased, and some of the dissolved gas is liberated in the form of bubbles, thus producing the familiar "sparkling" effect. Natural carbonated waters, e.g., Seltzer and Apollinaris waters, are formed in a similar manner by underground water dissolving carbon dioxide under pressure.

When gases dissolve from a mixture, instead of from the pure gas, each gas behaves independently of the others, and the amount that dissolves is the same as would have been the case for the pure gas at the same pressure it has in the mixture. This pressure is not the total gas pressure of the mixture, but the pressure which the particular gas contributes to the total, often referred to as the partial pressure of the gas in the mixture.

**Liquids.** Many pairs of liquids are able to mix with one another in all proportions, a homogeneous solution being formed irrespective of the relative quantities of the two liquids present. This result occurs when the liquids are similar or are related chemically, e.g., water and ethyl alcohol, and benzene and toluene, or if the molecules have a strong attraction for one another, possibly combining chemically. At the other extreme are found pairs of liquids which are so dissimilar that they are essentially immiscible, and neither liquid will dissolve the other, e.g., mercury and water, benzene and water. Between the two extremes lies an important type of system consisting of pairs of liquids that are partially miscible, e.g., water and ether. If two such liquids, A and B, are mixed, two layers will generally be formed, one being a saturated solution of A in excess of B, and the other a saturated solution of B in excess of A. The compositions of these two layers at equilibrium, called conjugate solutions, are perfectly definite, depending only on the temperature and to a very minor extent on the pressure. These compositions, are, however, independent of the relative amounts of the liquids A and B, provided only that the proportions are within the range for the existence of two conjugate layers. As a rule the mutual solubilities of two partially miscible liquids increase as the temperature is raised, and eventually a point is reached at which the liquids become miscible in all proportions. This point is known as the critical solution (or consolute temperature) of the system.

In a few instances, the mutual solubilities of two partially miscible liquids increase as the temperature is lowered. This effect occurs when heat is evolved upon mixing the liquids, usually as a result of chemical interaction. If the temperature can be decreased sufficiently without the system freezing, a lower critical solution temperature, in contrast to the upper temperature described above, may be observed. It is probable that all systems exhibiting a lower critical-solution temperature would also show such an upper temperature, although the reverse is not necessarily true. In most cases, however, one or other of the liquids boils before the upper critical solution temperature is attained. The nicotine-water system has a lower critical solution temperature at 61° C. and an upper temperature at 208° C. Below the former temperature and above the latter these liquids are miscible in all proportions, but within this temperature range they are only partially miscible.

**Solids.** Solids invariably exhibit a limited solubility in liquids. The composition of the saturated solution has a definite value at each temperature, depending on the nature of the solute (solid) and solvent (liquid) (*see* Table 2). The

Table 2. Solubilities of Certain Solids
*(Grams in 100 grams of water)*

| *Substance* | *0° C.* | *20° C.* | *100° C.* |
|---|---|---|---|
| Barium chloride, $BaCl_2 \cdot 2H_2O$ | 31.6 | 35.7 | 58.8 |
| Boric acid, $H_3BO_3$ | 1.95 | 4.00 | 27.5 |
| Calcium hydroxide, $Ca(OH)_2$ | 0.185 | 0.165 | 0.077 |
| Potassium chloride, KCl | 27.6 | 34.0 | 56.7 |
| Sodium chloride, NaCl | 35.7 | 36.12 | 39.8 |
| Sodium nitrate, $NaNO_3$ | 73.0 | 88.0 | 178.0 |
| Calcium carbonate | .... | 0.0013 | |
| Silver chloride | .... | 0.00016 | |
| Silver iodide | .... | 0.00000035 | |

solubility of sodium chloride in water is several million times as great as that of naphthalene; on the other hand, the situation is reversed when benzene is the solvent. The behavior is an illustration of the general rule that a solid will dissolve readily in a liquid to which it is related in certain chemical and physical properties, but will usually not dissolve in a liquid having an entirely different character.

Salts, in general, dissolve in water (*see* Table 3) and, to some extent, in related solvents such as alcohol and liquid ammonia. Even among salts, however, there are considerable

TABLE 3. SOLUBILITIES OF SOME SALTS AT 20° C.*

Expressed as the number of grams of the anhydrous salt held in solution by 100 cc. of water. In a few cases the temperature is other than 20° C.; in these instances the temperature is noted as a superscript. Notation: $0.0_82$ means 0.0000002.

| | $Ag^+$ | $Al^{+++}$ | $Ba^{++}$ | $Ca^{++}$ | $K^+$ | $Li^+$ | $Mg^{++}$ | $Na^+$ | $Pb^{++}$ | $Sn^{++}$ | $Sr^{++}$ | $Zn^{++}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $Br^-$ | $0.0_584$ | ... | 104 | 144 | 65.2 | 177 | 96.5 | 90 | 0.85 | $85.2^0$ | 102.4 | 477 |
| $BrO_3^-$ | 0.8 | ... | 0.65 | 8.6 | 6.9 | 155 | 27 | 34.5 | 1.32 | ... | 31 | 70 |
| $Cl^-$ | $0.0_315$ | 43 | 35.7 | 74.5 | 34.0 | 78.5 | 54.5 | 36.0 | 0.99 | 270 | 52 | $432^{25}$ |
| $ClO_3^-$ | 12.3 | ... | 25.26 | 179.3 | 7.4 | 313.4 | 33 | 101 | $151^{18}$ | ... | $174.9^{18}$ | 200 |
| $CO_3^=$ | 0.0032 | ... | 0.0022 | 0.0013 | 112 | 1.33 | 0.1 | 21.5 | $0.0_311$ | ... | 0.0015 | 0.001 |
| $C_2O_4^=$ | $0.0_335$ | ... | 0.01 | $0.0_36$ | 33 | 7.22 | 0.055 | 3.7 | $0.0_316$ | ... | 0.0046 | $0.0_38$ |
| $CrO_4^=$ | 0.003 | ... | $.0_337$ | 20 | 61.7 | 111.6 | 110 | 65 | $0.0_37$ | ... | $0.12^{15}$ | .... |
| $F^-$ | 196 | ... | 0.16 | 0.0017 | 94 | 0.3 | 0.008 | 4.44 | 0.064 | ... | 0.012 | $0.005^{18}$ |
| $I^-$ | $0.0_63$ | ... | 205 | 68 | 144 | 165 | $100^0$ | 178.7 | 0.068 | 1.0 | 177.8 | $430^0$ |
| $IO_3^-$ | 0.004 | ... | $0.0_302$ | 0.1 | 8.13 | $125^{15}$ | 86 | 9 | 0.003 | ... | $0.25^{18}$ | $0.8^{18}$ |
| $NO_2^-$ | 0.34 | ... | 40.3 | $37^0$ | 309 | $125^0$ | .... | .... | .... | ... | .... | .... |
| $NO_3^-$ | 222 | 36.2 | 9.2 | 330 | 31.6 | $71.4^{18}$ | $35^{18}$ | 88 | 56.5 | ... | 86 | 110 |
| $OH^-$ | 0.01 | ... | 3.89 | 0.165 | 112 | 12.08 | 0.001 | 109 | 0.0155 | ... | 0 8 | $0.0_63$ |
| $SO_3^=$ | ..... | ... | 0.02 | 0.03 | 84 | .... | 0.5 | 26.9 | .... | ... | .... | 0.13 |
| $SO_4^=$ | 0.79 | 26.7 | $.0_324$ | 0.20 | 11.11 | 25 | $26^0$ | 50 | 0.0041 | 19 | 0.0114 | $53^{18}$ |

* Reprinted from Foster and Alyea, *An Introduction to General Chemistry,* third ed., 1947, by permission of the publishers, D. Van Nostrand Company, Inc., New York.

variations; thus, ammonium nitrate is many million times more soluble in water than is silver iodide.

When a solid dissolves in a liquid, heat is usually absorbed; i.e., the heat of solution is negative. Hence, by the Le Châtelier principle, the solubility of the solid should increase with rising temperature. Such is the case, although the extent of the increase varies considerably from one solid to another. In a few instances, e.g., calcium sulphate and acetate in water, the solubility decreases to some extent as the temperature is raised. When the solubility increases appreciably with the temperature, the process of purification by recrystallization is possible. The impure solid is dissolved at a high temperature and the saturated solution is cooled. The excess solid solute then separates out, and the impurities largely remain in solution.

Solids can be completely or partially miscible, or completely immiscible with one another, just like liquids. Two suitable solids can thus form a homogeneous mixture that is a true solid solution, analogous to a liquid solution. Partially miscible solids can, similarly, form two conjugate solid solutions in equilibrium; the compositions of these solid solutions vary with the temperature, and critical solution temperatures are possible. Many pairs of metals are completely miscible in the solid state, whereas others are partially miscible or are virtually immiscible. These facts are of great importance in connection with the study and production of metallic alloys.

Solid solutions are not prepared by mixing the solids, because of the slowness with which the atoms or molecules of one solid would diffuse among those of the other. For metals and certain solids that can be melted without decomposition, the two solids are mixed and heated until they are completely molten; upon cooling the resulting liquid, the solid solution separates out. A mixture of suitable isomorphous salts may be dissolved in water, and upon evaporating or cooling, a solid solution of the two salts will crystallize from the liquid solution.

**Distribution Between Solvents.** If any solute is added to a system of two immiscible or slightly miscible liquids, the solute distributes itself between the two liquid solvents in a definite manner. Provided the solute has the same molecular weight in the two solvents, the ratio of its concentrations in the two layers is found to be constant, at any given temperature, irrespective of its total amount. This rule is known as the distribution law, or partition law; and the ratio of the concentrations is called the distribution ratio, or partition ratio, of the solute for the two specific liquids. The distribution ratio is approximately equal to the ratio of the saturation solubilities, so that a solute distributes itself between two liquids roughly in proportion to its normal solubility in those liquids. This result is utilized in the laboratory and in industry for the extraction of a required substance from its solution in one solvent by the use of another solvent. Another application is in the Parkes process for extracting silver from lead, with which it is frequently associated in nature. The impure lead is melted and molten zinc is added, thus forming two almost immiscible liquid solvents. The silver, which is present in the lead, distributes itself between the two liquid layers, the larger proportion passing into the zinc layer, in which it is more soluble. The upper (zinc) layer is then separated, and the zinc is removed by distillation, leaving most of the silver originally present in the lead.

## CONCENTRATION

**Molality.** The concentration of a solution is a means of expressing its composition in a convenient form. The concentration may be stated in terms of the percentage composition, but for most scientific purposes other methods are used. For example, the molar concentration, or molarity, of a solution is the number of moles, or gram-molecular weights, of the solute present in 1 liter of solution. Since the volume of a solution varies with the temperature and pressure, the molarity of a given solution will change accordingly. This

variability is a disadvantage for certain theoretical studies, and therefore the molality, which is independent of temperature and pressure, is used. The molality of a solution is the number of moles of solute to 1,000 grams of solvent. For a given solvent and solute, the molarity and molality of a series of solutions of different concentrations are proportional to one another, provided the solutions are dilute. For moderately concentrated solutions the proportionality no longer holds.

**Mole Fractions.** In many circumstances it is neither possible nor desirable to distinguish between solvent and solute; the mole fraction may then be employed to express the composition of a system. The mole fraction of any constituent of a solution, which may be gaseous, liquid, or solid, is the number of moles of that constituent divided by the total number of moles of all the substance present. The mole fractions of all the constituents of the solution thus add up to unity. An exact relationship may be derived between the mole fraction of a solute and its molarity and molality; for dilute solutions of a given solute and solvent, these three quantities are proportional to each other.

**Normality.** A convenient method for expressing concentrations, which is widely used in quantitative chemical analysis, is to state the normality of a solution. A normal solution of given solute contains 1 gram equivalent weight of that solute for liter of solution. A given volume of a normal solution of one solute, e.g., an acid or an oxidizing agent, is chemically equivalent to the same volume of a normal solution of another solute, e.g., a base or a reducing agent, respectively. The normality of any solution is the concentration in terms of that of the normal solution taken as unity.

A less precise indication of concentration makes use of the saturated solution as the reference standard. A solution containing less than the saturation amount of solute, at the given temperature, is said to be unsaturated; but if by some device it is made to contain more, it is called a supersaturated solution. An even more indefinite description is to refer to solutions as dilute or concentrated, with various qualifications. *See also* CHEMICAL EQUILIBRIUM; EQUIVALENT WEIGHT; METALLURGY, PHYSICAL. S. Gl.

**SOLUTREAN** [solu′triən], the name applied by archaeologists to an Upper Paleolithic culture from Solutré, near Mâcon, Saône-et-Loire, France, where the first examples of this culture were found. Highly typical are leaf-shaped lanceheads with shallow pressure-flaking on either face. Traces of this culture have been found in France, northern and eastern Spain, and in parts of central Europe. J. G. D. C.

**SOLVAY, ERNEST** [sɔ′lve′] (1838-1922), Belgian inventor of the ammonia process for making sodium carbonate (washing soda), was born on April 16, 1838, at Radeck. Educated at Liége, he showed great interest in industrial chemistry, and in 1863 opened a factory at Couillet, Belgium, for the manufacture of soda by his process. By 1913 he had obtained a virtual monopoly of the world's supply of soda. There is a large soda-ash works located in Solvay, New York. Service to his native country included membership in the Senate (1893-1900), philanthropy to both educational and charitable purposes, and supervision of the distribution of foodstuffs from the United States to France and Belgium during World War I. Solvay founded the École de Commerce and École de Sciences Politiques et Sociales, also the International Institute of Chemistry and Sociology, all in Belgium. He was president of the International Institute of Bibliography, Grand Officer of the Order of Leopold, honorary member of the Royal Institute of Great Britain, and Lavoisier medalist of the Institute of France. He died in Brussels, May 26, 1922. H. N. A.

**SOLVAY** [so′lve], a residential and industrial village in central New York, in Onondaga Co., situated near Lake Onondaga, 3 mi. west of Syracuse. Founded in 1884, it was incorporated as a village in 1894. Solvay has the mayor-council form of government. Transportation is supplied by the New York Central and the Delaware, Lackawanna and Western railroads. Solvay is widely known for its manufacture of soda and soda ash. Besides these products, the factory output includes dyes, ammonia, and oven coke. Pop. 1950, 7,868.

**SOLVENTS, INDUSTRIAL,** are used commercially for preparing solutions (molecular dispersions) of one material, known as the solute, in another, called the solvent. Solutions differ from mechanical mixtures in that they are homogenous throughout. Unlike true chemical compounds, the proportions of the components of a solution are not fixed but may vary up to the limit of solubility of one material in the other.

**Liquid Solvents.** Although solids, liquids, or gases may form solutions, the most common types are those in which a liquid is the solvent. When a solution is composed of two liquids, either may be considered as the solvent; however, this term usually designates the one present in the larger proportion. Most industrial solutions contain more than two ingredients, and frequently more than one solvent. Water meets many of the requirements of an ideal solvent. It is cheap, nontoxic, noninflammable, has a high solvent power for many materials, and is stable to heat. Also its boiling point is high enough to permit handling at room temperature without excessive solvent losses, and yet low enough to evaporate in a reasonable period of time. Its principal disadvantages are that it requires more heat to vaporize than other liquids; it is difficult to remove from many materials; and often fortunately, it will not dissolve everything. For these and other reasons, a wide variety of solvents have come into use. They may be divided into reactive solvents, which change the solute chemically in such a way that the original material cannot be recovered by evaporating the solution, and nonreactive solvents, which do not affect the chemical nature of the solute. Most industrial solvents are of the nonreactive type.

*Composition.* Solvents vary in chemical composition. The simplest are the hydrocarbons derived from coal tar or petroleum. These materials are cheap and consequently are used whenever possible. The main disadvantages of the hydrocarbons are their flammability and relatively low solvent power for certain materials. The chlorinated hydrocarbons are better solvents and much less flammable. Certain members of the series are toxic, however, and their use is restricted to applications which can be carried out without endangering the operators. In general, the oxygen-containing solvents, including alcohols, ketones, ethers, and esters, are more expensive than the hydrocarbons or chlorinated hydrocarbons, but in many applications none of the less expensive types perform satisfactorily.

*Uses in Protective Coatings.* One of the largest users of solvents is the protective coating industry, which manufactures paints, varnishes, lacquers, and various other specialized coatings. Paints and varnishes form a protective film by the drying of the oil base after the solvent has evaporated, and the primary purpose of the solvent is to thin the drying oil

to the correct viscosity for brushing. Gum turpentine was preferred for this purpose for many years, but recently substitutes derived from coal tar and petroleum have come into use. Unlike paints and varnishes, lacquers lay down a film by the evaporation of the solvent. The true solvents for nitrocellulose and other film-forming materials used in lacquers are relatively expensive; therefore diluents are added to reduce the cost of the solution. The choice of solvents and diluents must be made carefully if a satisfactory product is to be obtained. For example, it is necessary to balance the lower-boiling solvents, such as ethyl and isopropyl acetates and ethyl alcohol, with the higher-boiling butyl and amyl acetates and alcohols to prevent blushing or clouding of the film. Blushing occurs when moisture is condensed on the fresh lacquer film because of the cooling resulting from the rapid evaporation of low-boiling solvents. Unless higher-boiling solvents are present to carry off the water, a discolored and relatively nonadherent film is left. The lacquer formulator must also be sure that enough slower evaporating solvents are present to permit the film to flow to a smooth, even surface before it sets; otherwise buffing will be required to produce a satisfactory coating. The hydrocarbon diluents must evaporate before the last of the solvents, or an uneven precipitated film will result. These and many other problems must be solved in the formulation of a satisfactory lacquer.

Modified lacquers are used in coating textiles and leather. Since the coating and drying operations can be carried out under controlled conditions of temperature and humidity, it is possible to use a higher proportion of low-boiling solvents such as ethyl and isopropyl acetates, and even acetone, in the solvent mixtures. Low-boiling solvents are also used in coating textiles with some of the newer resins, such as the vinyls and cellulose acetate. Acetone is the principal solvent used in the manufacture of cellulose acetate rayon. Some of the coating compositions used for waterproofing textiles are similar to rubber cements, which consist of rubber dissolved in hydrocarbons. Chlorinated hydrocarbons may also be used, and these solvents are also valuable in cements based on oil-resistant synthetic rubbers.

*Other Uses.* Large volumes of solvents are used in various cleaning operations. Dry cleaning requires a solvent which will remove dirt and stains without affecting the dyes or the fabric. Stoddard solvent, a petroleum product boiling considerably higher than gasoline, is used in many operations, but because of its flammability it has been replaced to some extent by chlorinated hydrocarbons, such as trichloroethylene and carbon tetrachloride. Trichloroethylene and perchloroethylene are also used in degreasing metal and leather. The primary requirement for solvents to be used in the food, drug, and cosmetic industries is that they be nonpoisonous. In addition the solvent must not impart an undesirable taste or odor to the product. For these reasons ethyl alcohol is the preferred solvent for the preparation of tinctures, extracts, and other solutions. Polyhydric alcohols such as glycerin, and ethylene and propylene glycols, are also used where a less volatile material is required.

**Solvent Extraction.** Extracts are prepared by treating a solid or liquid with a solvent which will dissolve the desired components selectively. In this process, known as solvent extraction, the solvents must meet several requirements. They must dissolve the maximum amount of the desired component with a minimum of undesirable materials. The solution must be easy to separate from the undissolved substance. In the extraction of solids, this separation is usually not difficult, but in "liquid-liquid" extraction a solvent must be chosen which will separate quickly and completely from the liquid being extracted. The final requirement is that the solvent be easy to separate from the extracted material, usually by distillation, without affecting the quality of the product. Solvent extraction is widely used industrially. Almost every type of solvent finds some applications in this field. Petroleum derivatives boiling in the same temperature range as gasoline are used for the extraction of oil from soybeans and of chlorophyll from alfalfa. Alkaloids for pharmaceuticals are extracted with ether, and hormones are extracted with butanol. Methanol extracts the fatty acids, which become rancid, from the more stable acids; it also removes the sulphur-containing compounds which cause corrosion and undesirable odors in gasoline. Trichloroethylene and other chlorinated solvents are employed in the purification of vegetable oils, and butyl and amyl acetates extract penicillin from its fermentation liquor.

**Liquefied Gases.** In addition to solvents which are liquids under ordinary conditions, some liquefied gases are also used in solvent extraction. Propane, one of the components of natural gas, can be liquefied under pressure; and under the proper conditions liquid propane will extract vitamins from fish-liver oils. Asphalt is removed from lubricating-oil stock with the same solvent. Sulphur dioxide and ammonia are two other normally gaseous materials which have been proposed as suitable solvents for extraction. Solvent extraction is widely used in refining petroleum and vegetable oils, and new applications of this useful process are constantly being made. R. F. T.

**SOLWAY FIRTH** [sɒ′lwe], an arm of the Irish Sea extending nearly forty miles inland between England and Scotland. It is noted for its dangerous tides, which rise with rapidity to form a bore three to four feet high. It extends inland in a northwesterly direction and is bounded by the counties of Cumberland, Kirkcudbright, and Dumfries. The rivers Esk, Nith, Annan, Eden, Derwent, and others empty into it. The firth abounds with fish. S. Van V.

**SOMALI.** *See* African Peoples.

**SOMALILAND** [somɑ′lila′nd], a coastal region of east Africa extending from Bab el Mandeb Strait at the head of the Gulf of Aden east to the horn of Africa at Cape Guardafui and thence south and southwest to Ras Chiamboni (Dicks Head) southwest of the Giuba (Juba) River. To the west are Ethiopia and Kenya. The name is derived from the Somalis, a nomadic Moslem people of Hamitic stock and speech. Politically the region is divided into British, French, and Italian dependencies.

### BRITISH SOMALILAND

British Somaliland is a protectorate facing north on the Gulf of Aden. With a coastline of about 450 mi., it is bounded on the east and southeast by Italian Somaliland, on the south and west by Ethiopia, and for a short distance on the west by French Somaliland. The area is about 68,000 sq. mi.

**Geographical Features.** The main topographical features of the country parallel the coastline. The low, flat coastal plain extends inland about 60 mi. in the west and tapers to one or two miles in the east. Beyond the plain the land rises in precipitous escarpments to a lofty plateau, which slopes from an altitude of 7,000 ft. in the west to 2,000 ft. in the east. The climate is hot and arid, especially along the coast; rainfall averages from 8 to 20 in. a year. There is, however, considerable seasonal variation from this

average, which accounts to some extent for the migratory character of the population. Where rainfall is adequate there are a few small forest areas, but the country as a whole varies from desert scrub through grassland to park land. Varieties of gazelles are found on the plateau, and there the lion still preys on nomadic flocks.

**Population.** The population has been estimated to be between 500,000 and 700,000. Most of the people are nomadic Somalis who are Sunnite Moslems. Their principal occupation is grazing camels, sheep, and goats. The two towns of appreciable size are Berbera and Hargeisa, each with a population of about 15,000 in the hot season and 20,000 in the cooler season; Hargeisa is the capital. Non-natives include about 1,500 Arabs, about 500 Indians, and a very small number of Europeans.

*A ROPE MARKET AT HARGEISA, COMMERCIAL TOWN IN BRITISH SOMALILAND, IN WHICH WARES ARE DISPLAYED IN THE MIDDLE OF THE STREET*

COURTESY OF THE BRITISH INFORMATION SERVICES

**Economic Activities.** Little agriculture is practiced, and that is confined to the western part of the country. The principal export items are sheepskins and goatskins; some trade is done also in live sheep and goats, and such forest products as gums and resins. Frankincense and myrrh, once the chief source of wealth, have dwindled to insignificance. The export trade varies from about $1,000,000 to $2,000,000 annually. The country has no railways, but Berbera, an administrative center, is connected by air with Aden, to the north, and Nairobi, to the south. A reasonably good system of roads connects inland towns with those on the coast. Transport is by camel or motor car. The principal ports are Zeila, near the western border, and Berbera, 125 mi. east of Zeila. The East African shilling is used for currency.

**History and Government.** After the British established a protectorate over Aden in 1839, the Turks countered with a protectorate over Somaliland, but it was never effectively exercised. Between 1864 and 1884 Egypt established some control over Somaliland, but in the latter year this was replaced by a British force from Aden. Treaties were concluded with local chieftains, and in 1887 a formal protectorate was declared over the entire coast now within the limits of British Somaliland. Tribal warfare being endemic in the country, the British had frequent occasion to defend friendly clans against others, and in 1901 they were faced with a combined attack on their own forces by a group of clans under the leadership of Mohammed ibn-Abdullah, whom they called the Mad Mullah. Mohammed continued his attacks intermittently until 1920, when he was decisively beaten by a combined air and land attack.

Between 1884 and 1898 Somaliland was a dependency of Aden, which in turn was a dependency of India. From 1898 to 1905 it was under the direct control of the British Foreign Office and then was transferred to the Colonial Office. In World War II, from August 1940 to March 1941, the country was occupied by an Italian force; thereafter it was under a British military governor until April 1948, when civil government was resumed.

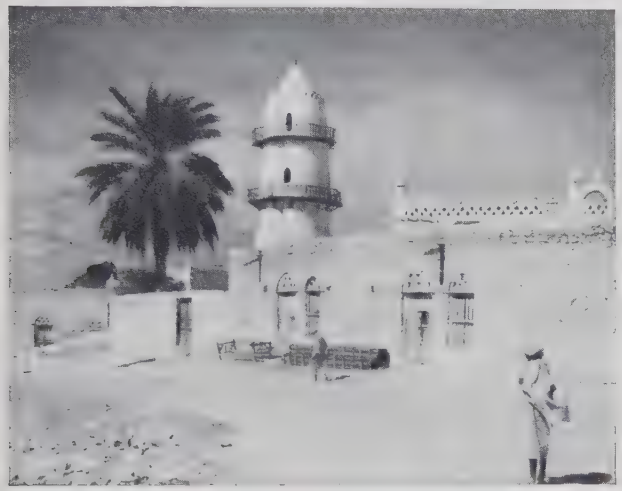
## FRENCH SOMALILAND

French Somaliland, a territory within the French Union, commands the narrow Bab el Mandeb Strait which connects the Red Sea and the Gulf of Aden. It is bounded on the north by Eritrea, on the west and south by Ethiopia, and on the east by British Somaliland, and the Gulf of Tadjoura. Across the strait is the tiny (1 sq. mi.) French territory of Cheik-Saïd, between Yemen and Aden. Smallest of the three dependencies, French Somaliland has an area of 9,071 sq. mi.

**Geographical Features.** The territory's coastline is so deeply indented (130 mi.) by the Gulf of Tadjoura that no part of the interior is more than 70 mi. from the shore. Such soil as is suitable for agriculture follows a low and narrow strip along the coast, but rainfall seldom exceeds 5 in. annually. Although there is greater precipitation farther inland where elevations are higher, the terrain is too rugged and the soil too thin for agricultural occupations.

**Population.** The population in 1952 was 61,625, including 27,360 Somalis, 25,202 Danakils, 6,007 Arabs, and 2,357 Europeans. The native groups are Moslems, largely Sunnites; however, the Danakils have retained many features of animistic fetish worship along with the practice of Islam. These people, most of whom live north of the Gulf of Tadjoura, regard themselves as Arabs, but speak a language akin to Somali. They are of Hamitic origin. Djibouti (pop. 1952, 27,723) is the capital.

**Economic Activities.** Except near the British Somaliland border, little of the territory is well suited to agricultural or even pastoral pursuits. The only major export is salt, but hides and coffee add some value to the export trade. The territory's major role is in its strategic commercial and military location. The railway to Addis Ababa (496 mi.) carries part of Ethiopia's trade with the outside world, despite the fact that the country's federation with Eritrea in 1952 gave landlocked Ethiopia an outlet to the sea. The monetary unit of French Somaliland is the Djibouti franc, which is valued at 214 to the U.S. dollar.



EWING GALLOWAY

*The ancient Mosque of Djibouti, capital city of French Somaliland, at which the Moslem inhabitants gather to worship*

**History and Government.** The French established a settlement at Obock on the Gulf of Tadjoura directly north of Djibouti in 1862 but did not take formal possession until 1883. Between 1883 and 1887 French boundaries were extended by treaties with local sultans, and in 1888 France secured from Great Britain undisputed control over the south coast of the gulf. The capital was moved from Obock to Djibouti in 1892. The Eritrean boundary, fixed in 1894, was readjusted in 1935 when France ceded 309 sq. mi. to Eritrea. France concluded a territorial and economic agreement with Ethiopia in 1897, and in the same year the construction of the railway was begun, although it did not reach Addis Ababa until 1917. Relations between French Somaliland and its neighbors have been amicable, thus maintaining for France a secure trading and fueling station on its route to Asia.

An appointed governor is responsible for administration. Since 1945 he has been assisted by an administrative council consisting of appointed and elected members with separate electorates for French citizens and native races. In each of the French governmental divisions—the French National Assembly, the Council of the Republic, and the French Union—the territory is represented by one delegate.

## ITALIAN SOMALILAND

Italian Somaliland, or just Somaliland, is a former Italian colony restored temporarily to Italian administration by the United Nations in December 1949. It has a coastline of 1,250 mi. facing east and southeast on the Indian Ocean; the coast continues around Cape Guardafui, giving it a 150-mi. shoreline facing north across the Gulf of Aden. It is bounded on the northwest by British Somaliland and Ethiopia, and on the west and southwest by Kenya. Largest of the dependencies, it has an area of about 190,000 sq. mi.

**Geographical Features.** Almost half of Italian Somaliland is less than 600 ft. above sea level, and only along the British Somaliland border do elevations reach more than 3,000 ft. The coastal lowlands, which are more than 200 mi. broad in the south, steadily narrow toward the northeast and disappear near Alula west of Cape Guardafui, where an escarpment of almost 1,000 ft. directly fronts on the sea. These higher areas of the northeast, however, receive less rainfall than the lowlands toward the southwest. In the lower Giuba and Shibeli valleys on the equator the precipitation may reach 30 in. annually, most of it between April and June; throughout most of Italian Somaliland, however, it is under 10 in. By far the greater part of the country must be classed as desert or semidesert. The only perennial rivers are the Giuba and its tributary, the Shibeli, both of which rise in the well-watered mountains of southern Ethiopia. The Giuba flows directly south from the Ethiopian border and empties into the Indian Ocean; the Shibeli farther to the northeast approaches to within 20 mi. of the sea in the vicinity of Mogadiscio, the capital, and then parallels the coast for over 200 mi. before emptying into the Giuba just before its mouth. The coastal region from Chisimaio near the mouth of the Giuba to Mogadiscio is known as Benadir. As a whole, the coast is poorly supplied with natural harbors; Chisimaio is the best, but breakwater construction at Mogadiscio offers protection against monsoons, and the port has adequate shipping facilities.

**Population.** The population in 1952 was about 1,280,000, the majority of whom were Somalis, a semi-nomadic pastoral people. There are also about 30,000 Arabs, 1,000 Indians, and 5,000 Italians. Some Bantus are found in the south, and there are communities of Arabs and Swahilis in the coastal towns. Most of the population is Moslem.

**Economic Activities.** The chief native crops are cereals such as maize, millet (sorghum), and vegetables, none of which is raised in excess of local needs. The principal exports are dressed sheepskins and goatskins, but there is also some export of cattle, myrrh, and gum arabic. Camels, an essential part of the native economy, are not raised for export. Between World War I and World War II Italian planters and plantation companies established irrigation farming on the lower Giuba and along the Shibeli. Some land, especially on the lower Giuba which has a flood plain about 4 mi. wide, is self-irrigating. Plantation crops include cotton, sugar cane, tobacco, and maize. There are no minerals, almost no secondary industries, and little trade. On balance Italian Somaliland has been an economic liability to the administering power.

**History and Government.** Within historic times Italian Somaliland has been successively under Portugal, Oman, Zanzibar, and Italy. In 1889 the Benadir coast was granted to Italy by the sultan of Zanzibar, and between 1893 and 1905 was leased to a private company. In the latter year the Italian government assumed control. Full sovereignty over the northeast was not established until 1925, although previously a group of protectorates had been set up over local sultanates. Here the situation had remained fluid, so long as Mohammed ibn-Abdullah, the Mad Mullah, continued to use this rugged region as a refuge from British attack farther to the west. With his final defeat in 1920 northeastern Italian Somaliland became fairly tranquil. In 1925 the British ceded the region to the west of the Giuba River known as Jubaland. The continued absence of any definite boundary between Italian Somaliland and Ethiopia, together with the seasonal migration of tribesmen between the two countries, has made for unsettled conditions in that region. With the Italian conquest of Ethiopia in 1936, all Italy's holdings in

east Africa were united under the name of Italian East Africa. Italian Somaliland was occupied by the British in 1941 and remained under British military administration until the United Nations, charged with the disposition of the former Italian colonies, decided to return the territory to Rome under a U.N. trusteeship in 1949. The U.N. decision, however, stipulated that the country was to become independent in 1960. Under the trusteeship arrangement, Italy's administration is reviewed annually at U.N. sessions, with member nations taking an active interest in Somaliland's progress toward self-government. The postwar period saw an emerging Somali political movement, and the territory's first municipal elections in 1954 resulted in widespread victories for the Somali Youth League, the leading nationalist party. W. M. W.

**SOMBOR** [so′mbor], an agricultural and trading town in Voivodina, Yugoslavia, about 95 mi. northwest of Belgrade and 20 mi. from the Hungarian border. It is on the Kanal Kralfa Petru (Francis Canal) which connects the Danube and Tisa rivers. Taken from the Turks in the seventeenth century, Sombor was a Hungarian royal free town before World War I. Flour milling, match manufacturing, and trading in agricultural products are the principal economic activities in Sombor, which has rail connections with Subotica and Belgrade and with centers north in Hungary. Pop. 1948, 33,613. F. Sc.

**SOMERSET, EDWARD SEYMOUR, DUKE OF** (c. 1506-1552), Protector during the reign of Edward VI, was born about 1506 and educated at Oxford and Cambridge universities. He took part in an expedition to France in 1523 and came increasingly into favour with Henry VIII. In 1536, after his sister Jane Seymour's marriage to the king, he was made Viscount Beauchamp, and in 1537 he was created Earl of Hertford. He became lieutenant general in the north in 1544 and invaded Scotland, capturing and pillaging Edinburgh. During the next year, he played a brilliant part in the war against France and again invaded Scotland. Hertford was now the rival of the Catholic Duke of Norfolk for power, and when Edward VI succeeded to the throne (1547), it was Hertford, now the Duke of Somerset, who became Protector. However, his vigorous Protestant policy made him unpopular with many people. He defeated the Scottish army at Pinkie Cleugh but failed to secure the marriage of Edward to Mary, Queen of Scots. He sympathized with Kett's agricultural rebellion in East Anglia (1549), which alienated the landowners, and the conviction of his brother for treason further weakened his position. In January 1550 the Council deposed him as Protector and in October 1551 he was sent to the Tower of London on a concocted charge of treason backed by his bitter rival, the Earl of Warwick. He was tried, condemned, and executed on Tower Hill on Jan. 22, 1552. E. R. A.

*Tapestry-hung room at Montacute House, a fine stone manor house west of the town of Yeovil in Somersetshire. The house, now owned by the National Trust and open to the public, was built between 1580 and 1601 for Sir Edward Phelips by the noted Elizabethan architect John Thorpe.*

COURTESY OF THE TRAVEL ASSOCIATION

**SOMERSET,** a city in south central Kentucky, the county seat of Pulaski Co., situated 100 mi. southeast of Louisville, in an agricultural area where corn and tobacco are leading crops. Coal and timber are natural resources of the region. Somerset was made the county seat by court order in 1801. The city government is the mayor-council type. Transportation is provided by the Cincinnati, New Orleans & Texas Pacific Railway. Local industries include oil refining, flour milling, bottling, and the processing of dairy products. Pop. 1950, 7,097.

**SOMERSET,** a residential and resort village and town in southeastern Massachusetts, situated in Bristol Co., on the Taunton River, 40 mi. south of Boston. Founded in 1677, it was incorporated as a town in 1790. Somerset's government is the town-meeting type. Transportation is provided by the New York, New Haven and Hartford Railroad. Pop. 1950, (town) 8,566; (village) 4,296.

**SOMERSET,** a borough in the southwestern section of Pennsylvania, the county seat of Somerset Co., situated about 60 mi. southeast of Pittsburgh. The region is a rich anthracite coal district. Founded in 1795, Somerset was incorporated as a city in 1804. The borough government is the burgess-council type. President William McKinley maintained a summer "White House" in Somerset, which is a popular summer resort. Transportation is furnished by the Baltimore & Ohio Railroad, which maintains railroad shops in the borough. Building materials and wooden columns constitute the chief industrial products. Pop. 1950, 5,936.

**SOMERSETSHIRE** or **SOMERSET,** a maritime county in southwestern England, with an area of 1,620 sq. mi. It is bounded by the Bristol Channel on the north, the counties of Gloucester and Wiltshire on the east, Dorset and Devon on the south, and Devon on the west. The northern coast is low and marshy in the east; in the west it is lined with high slate cliffs. In the interior of the country is a series of hill ranges separated by the valleys or low, marshy flats. The chief ranges are the Mendip Hills, Polden Hills, Quantock Hills, Brendon Hills, and Exmoor. The Avon and the Parrett are the chief rivers. There are many orchards, and sheep and cattle are raised. There are coal measures in the northeastern part of the county, and the quarries of the famous Bath stone. In the west are the wild moorlands of Exmoor. The chief minerals are iron, manganese, and slate. The manufactures are woolens, gloves, lace, linens, and Bath brick. There are also pottery and printing works. Salmon and herring are caught in the Bristol Channel.

Caves, containing fine specimens of stalactites, stalagmites, and other rock formations, are found near Cheddar, world-famous for its cheese. Glastonbury owes its fame to the old ruined abbey, the history of which dates from an ancient church, said to be the first in England. It became a Benedictine abbey in 940. The remains of King Arthur and Queen Guinevere are supposed to have been discovered here in 1191 and reinterred in 1276. The present ruins date from the abbey which was built from 1185 to 1303 to replace the one that was burned in 1184. One of the finest cathedrals in England is at Wells, an attractive old city. Bath, the larg-

est town in Somerset and the most famous spa in England, is noted for the ruins of a Roman bath. The town has been written about by such famous authors as Jane Austen, Sheridan, Smollett, and Thackeray. Somerset sends six members to Parliament. Pop. 1952, 557,100. S. Van V.

**SOMERSWORTH** [sʌ′mərzwɜrth], a city in southeastern New Hampshire, situated in Strafford Co., on the Salmon Falls River, 33 mi. east of Concord, and opposite Berwick, Me., with which it is connected by bridge. The surrounding agricultural area is devoted principally to truck, dairy, and fruit farming. Somersworth was incorporated as a parish in 1729, as a town in 1754, and as a city in 1893. It was known at first as Great Falls. The city government is by mayor and council. A feature of the city is the Joseph Wentworth House, built in 1750. Transportation is supplied by the Boston and Maine Railroad. Local industries include woolen mills, shoe factories, and dye, bleaching, and bottling works. Pop. 1950, 6,927.

**SOMERVILLE** [sʌ′mərvɪl], a city in Middlesex Co., in eastern Massachusetts, just north of Cambridge and northwest of Boston. The community was founded as a part of Charlestown about 1630. The first ship built in Massachusetts was launched on the Mystic River in 1631 from Governor John Winthrop's farm on the city's site. On Prospect Hill, one of the community's seven hills, George Washington raised the first flag of the United Colonies on Jan. 1, 1776. The community was the scene of much activity during the Revolutionary War. Somerville was set off from Charlestown as an independent town in 1842, and it became a city in 1871. Of historic interest are Old Powder House and the Oliver Tufts House, which served as headquarters for General Charles Lee during the Revolutionary War. Tufts College is partially located in Somerville and partially in Medford. The Boston and Maine Railroad provides transportation. Somerville is an important wholesale distribution point. Slaughtering, meat packing, and the assembly of automobiles are the chief industries. Others produce foundry, brass, copper, paper, and glass products. Pop. 1950, 102,351.

**SOMERVILLE,** a borough in central New Jersey, the county seat of Somerset Co., situated 25 mi. southwest of Newark. There are numerous dairy and poultry farms in the surrounding district. Founded about 1690 and at first called Raritan, Somerville was made the county seat in 1783 and was incorporated as a borough in 1909. The borough government is by mayor and council. In the parsonage of the Dutch Reformed Church, built in 1751, Rev. John Frelinghuysen established the first Dutch Reformed Theological Seminary in America, which developed into Rutgers University at New Brunswick. Features of the borough are the Wallace House, headquarters of George Washington in the winter of 1778 to 1779, and the Somerville Hotel, which includes the Tunison Tavern built in 1770. Of additional interest is the James B. Duke estate near by. Transportation is provided by the Central Railroad of New Jersey. Local industries manufacture cast-iron pipe, lace for trimmings, soft drinks, and linoleum. Pop. 1950, 11,571.

**SOMME** [sɔ′m], a historic department in northwestern France, bounded by Pas-de-Calais and Nord departments on the north, Aisne on the east, Oise to the south, Seine-Inférieure on the southwest, and the English Channel on the west. It has an area of 2,443 sq. mi. The surface is a rolling plateau; the Somme is the largest river. Agriculture is the chief industry; wheat, oats, sugar beets, vegetables, and cider apples are the major crops. Pharmaceuticals, metallurgical products, phosphates, and textiles are manufactured. There are wide coastal sand dunes to the mouth of the Somme. Back of the dunes is land reclaimed from the sea by dikes. In the Bay of the Somme are the fishing ports of St.-Valéry-sur-Somme, Le Crotoy, and Le Hourdel. St.-Valéry is the port into which William the Conqueror was driven during his first attempt on England. Amiens, the prefecture, is the center of the French textile industry and has one of the largest cathedrals in France. The Ancre and Avre rivers join the Somme at Amiens. Amiens and many other places in the department were heavily damaged in World War II. Abbeville, Crécy, Ham, Montdidier, and Péronne are important historic towns. At Corbie are remains of a seventh-century abbey. The department was formed in 1790, largely from the old province of Picardy, of which Amiens was also capital. Pop. 1954, 464,153. S. Van V.

**SOMME** [sɔ′m], a river in northwestern France, 153 mi. long, flowing from the hills near St. Quentin to the English Channel. It enters the Channel by way of an estuary starting at Abbeville, and Amiens is the principal city along its course. The river is navigable and is connected by canal with the Seine-Oise river systems. The valley of the Somme was the scene of much fighting in World War I and again in World War II when German mechanized units advanced downstream to Abbeville to cut off the retreating British and French armies. S. Van V.

**SOMMER, FERDINAND** [zɔ′mər] (1875- ), German linguist, was born in Trier, May 4, 1875. He studied at Kassel, Freiburg (Baden), and Marburg, received the doctor's degree at Freiburg in 1896 and then continued his studies in Leipzig. He became *Privatdozent* at Leipzig in 1899 and professor at Basel in 1902. Thereafter he held professorships at Rostock, Jena, Bonn, and, since 1926, at Munich.

Sommer is one of the greatest living Indo-Europeanists, combining a wide range of knowledge with sound philological training and exactness of information. His best known work is the famous *Handbuch der lateinischen Laut-und Formenlehre* (1902), the most important book in the field and an essential tool for every Latinist. He has also published outstanding books on the Greek language including *Griechische Lautstudien* (1905) and *Sprachgeschichtliche Erläuterungen für den griechischen Unterricht* (1917); he has worked in the Lydian, Etruscan, and Baltic fields. His *Vergleichende Syntax der Schulsprachen* (*Deutsch, Französisch, Englisch, Lateinisch, Griechisch*) (1921), is excellent.

Sommer was one of the very few Indo-Europeanists who, immediately after the discovery of Cuneiform Hittite in 1917 by B. Hrozný, recognized the purely Indo-European character of the new language. Entering this new and difficult field, which seemed reserved to Assyriologists, he soon acquired a preëminent position in it and is now a recognized authority in Hittite philology as well as in Hittite linguistics. He has published many works on Hittite, some of a very sharp polemic character but all of great importance, among them *Die Ahhijavā-Urkunden* (1920), *Ahhijavā-frage und Sprachwissenschaft* (1934), and *Hethiter und Hethitisch* (1947). Since 1925 Sommer has directed the series *Hethitische Texte,* and from 1926 on (with A. Debrunner) the journals *Indogermanische Forschungen* and *Grundriss der Indogermanischen Sprach- und Altertumskunde* (Berlin); in 1927 he founded, with H. Ehelolf, the *Kleinasiatische Forschungen,* devoted mostly to Cuneiform Hittite. G. B.

**SOMMERFELT, ALF AXELSSON** [sɔ'mərfɛlt] (1892- ), Norwegian linguist, was born at Trondheim, Nov. 23, 1892. He studied in Oslo and abroad, received a French doctoral degree in Paris in 1921, became *Privatdozent* at Oslo in 1926, and was appointed professor of general linguistics at Oslo in 1931. Sommerfelt is one of the most distinguished Norwegian linguists; he is a member of the Scientific Academy in Oslo and was director from 1923 to 1940 of the Institut for Sammenlignede Kulturforskning. He has represented Norway in many international scholarly organizations, among them the Conseil Permanent de Linguistes, the Commission d'Enquête Linguistique, the Permanent Committee for the Organization of International Congresses of Phonetic Sciences, and, since 1945, the UNESCO.

A specialist in Celtic and Germanic linguistics, Sommerfelt has also been profoundly interested in problems of general linguistics. His book *La Langue et la société* (1936), which is devoted to an analysis of the language of one of the most primitive peoples of the world, the Aranta of central Australia, sums up all his previous studies in the field and reaches conclusions of the greatest importance. Dealing with the relationship between language and the mental level of the speaker, and therefore with the formation and evolution of language and linguistic categories in general, it is a fundamental work for all studies of this kind. More popular works by Sommerfelt include *Hvordan sproget til* (1934), *Sproget som samfundsorgan* (1935), and *Hva er rase?* (1939). In 1942 he published, in English, *The Written and Spoken Word in Norway*. Sommerfelt has also published a number of specialized linguistic studies, made important contributions to scholarly journals, and since 1923 has been editing, with Prof. Trygve Knudsen, a dictionary of the *riksmål*.

G. B.

**SOMNAMBULISM,** sleepwalking, a dissociated state, manifested by automatic motor activity during sleep.

Adequate statistical data on sleepwalking are lacking, but it is generally recognized that the phenomenon is fairly frequent in childhood and disappears, as a rule, during adolescence. Incidence in adults, however, is considerably greater than is generally believed. Somnambulism may occur in otherwise apparently normal children and healthy adults, but in the adults it is more often associated with epileptic, chronic alcoholic, and psychotic conditions.

Popular legend assumes that sleepwalkers move in a state of deep sleep, with their eyes closed, yet skillfully avoiding all obstacles and never coming to any harm, unless roughly and suddenly awakened. This assumption is incorrect. Except for the comparatively rare cases of post-epileptic automatism, sleepwalkers are in a state of incomplete sleep, with their eyes open and pupils dilated and reacting to light. Although they may walk for miles, without injuring themselves, unfortunate accidents are frequent. The most common type of sleepwalking, caused by acute anxiety, often following traumatic battle experiences, is manifested by aggressive tendencies during the sleepwalking stage. The patients often injure themselves and others, and seem to be in a state of terror. They perspire profusely; have tense, rigid muscles; and have rapid, shallow respiration. They resist attempts to lead them back to bed, talk incoherently, but do not answer questions. Upon waking, there is no recollection of the experience.

Chronic anxiety sometimes results in a different type of somnambulism. Attacks are less frequent and less violent. Patients walk aimlessly for one or two miles before returning to bed, but their movements are slow, arms relaxed, and respiration quiet and regular.

B. Van R.

**SOMNUS** [sɒ'mnəs], the personification of sleep, identified by the Romans with Hypnos and hence the brother of Death and son of Night. *See also* Hypnos.

G. E. D.

**SONATA** [sonɑ'tə], an extended musical composition in one or more movements, for one or more instruments.

**History.** The word "sonata" (from the Italian *sonare,* "to sound") has undergone numerous refinements and changes in meaning since it was first used in Italy in the late sixteenth century to refer merely to any instrumental or "sound" piece as opposed to the *canzone* or *cantata,* which referred to a piece that was sung.

*The Baroque Sonata.* In the course of the seventeenth century the term "sonata" came to be identified chiefly with the music for small string ensembles whose sections were expanded into separate, contrasting movements; it was thus commonly used with reference to the music written for two violins and bass that was known subsequently as the "trio sonata." Notable exceptions to this practice were the organ sonata and the "sonata," or introductory movement in the German suite for wind instruments. In Italy, two somewhat interdependent types grew out of the instrumental *canzone* and the suite. These were the *sonata da chiesa,* or church sonata, which consisted typically of a homophonic slow movement, a fugal allegro, a brief transitional adagio, and a giguelike finale, and the *sonata da camera,* or chamber sonata, which consisted of a freer assortment of idealized dance forms, especially the allemande, courante, saraband, and gigue.

At the end of the seventeenth century, these types reached a peak of development in Italy in the trio and the accompanied violin sonatas of Arcangelo Corelli. At the same time, they were taken up by Heinrich Biber in Germany, Henry Purcell in England, and Couperin le Grand in France, all of whom modified them. Further important and extensive additions to this literature, now become international in style and of a uniformly high quality, were made by Bach, Handel, Gluck, Tartini, Jean Marie Leclair, William Boyce, and many others during the first six decades of the eighteenth century. The solo keyboard sonata, pioneered chiefly by Bernardo Pasquini and Johann Kuhnau at the end of the seventeenth century, received comparatively little attention at the hands of Bach and his contemporaries; for the most part it was adapted from the church and chamber types, but especially interesting were some 550 one-movement étude-like pieces, called "sonatas" as well as "exercies," by Domenico Scarlatti. Special mention must also be made of Bach's extraordinarily rich sonatas for solo violin and solo violincello.

*The Classical Sonata.* The Classical Viennese sonata, with its fluent homophony, structural symmetry, and dramatic contrasts, developed from the earlier sonata and reached its height at the end of the eighteenth century in the works of Haydn, Mozart, and Beethoven. The word "sonata" now came to be restricted to music for the newly popular piano or other solo instrument, with or without accompaniment. Music resembling the sonata but scored for a greater number of instruments was called, according to the ensemble that played it, a trio, a quartet, or a symphony. With Beethoven the sonata achieved an inexorable logic and a dramatic drive never surpassed. This is particularly true of his thirty-eight piano sonatas, of which the Pathétique, the Moonlight, and the Appassionata have the accepted stature of masterworks. Beethoven explored and utilized the various resources of the sonata form so thoroughly that he marked at once the culmination and the dissolution of the Classical sonata

idea, and in spite of unusually beautiful harmonies and melodies and wonderfully dramatic episodes, uneven quality has prevented most of the solo and duet sonatas of his immediate successor, Schubert, from achieving the general popularity they otherwise deserve.

*The Romantic and Twentieth-Century Sonata.* The four piano sonatas by Weber and the three each by Mendelssohn, Chopin, and Schumann, all composed before 1845, indicate at a glance that wealth and intimacy of harmony and melody were taking precedence over the strict economy and logic of balanced form in the Romantic Era, this notwithstanding the fact that their composers made a self-conscious effort to emulate the Classicists in this form. A distinguished and wholly Romantic exception is Liszt's B minor piano sonata (1854), which combines all the movements into one. On the other hand, the ten sonatas written variously for piano, violin and piano, violincello and piano, and clarinet and piano by Brahms (1833-1897) present a genuine extension of the Classical principles of form during the Romantic Era.

In the large number of sonatas that continued to appear around the end of the nineteenth century, the competent but slavish adherence to an overly formal concept of the Classical sonata is belied by the thoroughly Romantic and often nationalistic content. An important evidence of the desire for an ever-greater unity between the several movements of Romantic sonata music, a unity accomplished by Beethoven through inner stylistic and expressive kinship, was the time-honored and overt principle of reiterating the same idea from movement to movement, often with programmatic implications. Such, for example, was a main purpose of Franck's cyclic form which can be observed in his popular violin and piano sonata (1886).

The lasting validity of the Classical sonata idea is demonstrated by the fact that nearly every important twentieth-century composer has resorted to it in some of his major instrumental works. Compact terseness, as in Prokofiev, has often supplanted effusive Romantic prolixity, while the innovations of original tonal systems, as in Hindemith, has replaced cyclic procedures. Yet beneath these tendencies the basic regimen of the Classical sonata has continued to be operative.

**Sonata Form.** Sonata (or sonata-allegro, or first-movement) form is the name given to the special ternary design used almost invariably since the Classical Era in one or more movements of the sonata, symphony, concerto, and frequently the overture; it is also used in the trio, quartet, quintet, and other types of chamber music. In this form, two or more themes, separated by bridge passages and contrasted in character and tonality, are typically introduced in the exposition or first section of this design and usually repeated. These themes are then exploited at the composer's discretion, through extension, reiteration, dissection, and modulation, in the development, or second, section. In the recapitulation, or third, section they are finally restated so as to conclude in the original key, and the entire sonata sometimes ends with an added coda. The cumulative tension thus created by the thematic contrasts and the climactic development and the release accomplished by the restatement of the themes in the light of their foregoing development is of great musical appeal, and the lasting validity of this general form is indicated by its use in nearly all types of music.

While chance examples of sonata form occur sporadically in the Baroque sonata movements and with increasing frequency throughout the eighteenth century, the form did not become categorized until the nineteenth-century theorists classified it. Since then it has been a point of departure for innovations of varying consequence. Although the designations "masculine" and "feminine" for the principal themes are of Romantic origin, the Romantic sonata often sacrifices the tension of thematic contrast and development to a more static and even disruptive lyricism. An interesting tendency, evident especially among the later symphonists, such as Bruckner, Sibelius, and Shostakovich, and certainly anticipated by Beethoven in the third and fifth symphonies, is the use of germ ideas that are developed and expanded to the status of full themes during the entire course of the sonata form rather than in the central section alone. This tendency may account for the greatly curtailed recapitulation in many twentieth-century examples of the sonata form, since the continual development of the ideas makes their full restatement superfluous. W. S. N.

**SONATINA** [so′nɑti′nə] (lit. "little sonata"), a form of musical composition, usually for piano, having fewer and shorter movements than the full sonata; it is also somewhat less developed formally than the fuller form and is easier to play. Such sonatinas as those of Muzio Clementi were designed primarily as teaching pieces; Busoni and Ravel, on the other hand, wrote sonatinas which, although they were abbreviated in form, were technically as difficult and artistically as substantial as any ordinary sonata. The term "sonatina form" has occasionally been applied to "sonata allegro" movements, in which the exposition and recapitulation sections are connected by a brief transition rather than by a true development section. W. Li.

**SØNDERBORG** [sö′nərbɔrχ], a city on the island of Als, off the southeast coast of Jutland, Denmark. A bathing resort and the commercial center of the island, Sønderborg is 110 mi. southwest of Copenhagen, in an area of fertile farms on glacial moraine and outwash. The town, first settled in the thirteenth century, is located on both sides of the Alsensund, which separates the island of Als and the mainland of Nord Slesvig, Denmark. The near-by castle, built by Waldemar the Great in the twelfth century, was the scene of the imprisonment (1532-1549) of King Christian II and now serves as a museum for relics of the Second Slesvig War and other articles. This war was brought to an end by the defeat of Denmark by Germany at Dybböl Hill, near the town, in 1864. At that time the town, which was burned, was ceded with the rest of Nord Slesvig to Germany. In 1920 the area was returned to Denmark by plebiscite, and the Crown Prince established his summer home at near-by Graasten Castle. Pop. 1953, 16,571. J. E. V.

**SONDRIO** [sɔ′ndrio], a province and its capital located in the Valtellina in northern Lombardy, northern Italy.

**The City.** Situated at 46° 10′ N. lat., 9° 50′ E. long., Sondrio lies at an elevation of 940 ft. above sea level on the small Mallero River just above its confluence with the Adda. The city is a small commercial and industrial center of local importance. Sondrio has seldom played a vital role in history. During the Thirty Years' War, the strategically located Valtellina was much fought over by French, Spanish, Austrian and other armies. Pop. (off. est.) 1947, 13,836.

**The Province.** Sondrio, comprising 79 communes, has an area of 1,239 sq. mi. with a population density of 115 per sq. mi., one of the lowest in Italy. In recent years the population has declined because of extensive emigration from the mountain communes to the Lombard Plain and elsewhere. The province consists of the Italian part of the Adda River

valley above Lake Como, plus the upper reaches of the Livigno Valley. On practically all sides it is bounded by high mountains, including the Bergamo Alps on the south. Agriculture and stockraising are the leading occupations. Recently industries have made a small beginning in metallurgy, textiles, and woodwork. Pop. (off. est. 1947), 153,000.

R. G. W.

**SONG,** in the usual general sense of the term, the musical utterance of men. No group of men has ever been found to whom song is entirely unknown. Among primitive peoples two kinds of song exist; the commonest is a chant closely related to speech and using prose rhythms with but few tones, while the other is an accented type, inseparable from the dance.

Song serves a variety of purposes in human society. Many peoples believe that it possesses magic efficacy, and songs have always been widely used to express religious exaltation, praise, or petition to some great power. In the feudal period, songs were newsbearing chants, and ballads based on actual events are still composed in many parts of the world, including the mountain regions of North America, where accounts of Charles Lindbergh's flight and the sinking of the *Titanic* have had an enduring popularity. Songs are also used to lighten labor by facilitating the rhythmic co-ordination of movements; for example, sea chanteys and the track-laying chants of the railroad construction gangs add to both the ease and the efficiency of the work that they accompany, and their usefulness has been so well recognized that on sailing ships a good chanteyman used to be paid more than his fellow sailors. Again, certain kinds of songs are used instead of instruments to accompany dancing, as lilting in Ireland, "mouth music" in the Hebrides, and play-party songs in the United States.

The art song appears very early in the history of mankind. A combination of expressive poetry and melody, often accompanied by an instrument, it is composed primarily either for pure pleasure in song or to express some personal human emotion such as love, grief, or joy; this form of song is not intended for any special ritual or social use. Usually a song is the musical setting of a poem, either accompanied by a musical instrument or intended for the voice alone; but musical settings of nonsense syllables are not uncommon, and several composers have written pieces, called *vocalises,* which are intended for wordless singing. The popular songs which have a brief but intense existence on juke box and radio may be described as a commercial form of the art song.

It is now generally recognized that the old theory of the "communal composition of song" is erroneous and that all creative activity of this sort, in which a group participates, depends not on any mystical act of participation but upon a folk leader, who is to a greater or less degree a poet and composer. The typical process by which group songs are composed may be observed in many parts of the world. Among the Portuguese, for example, the *fado* is a type of song that allows the individuals of a group to take turns improvising successive stanzas. In practice, however, this improvisation quickly becomes the prerogative of the readiest singers; the variants produced by these more gifted members of the group soon become traditional; and these variants are repeated by others unable to compose their own. Many repetitions in the oral tradition simplify the original material to a greater or less degree, and in the course of time this erosion produces what we call a folk song, marked unconsciously by the taste and characteristics of a people.

There is every reason to believe that the individual composition of a solo song is a very old institution indeed, and not the product, as many writers in the late nineteenth and early twentieth centuries confidently asserted, of any given moment in the short span of Western musical culture. A spectacular example of a solo song that antedates the Christian era is the Chinese melody called *Peachblossom,* thought to be thousands of years old. It first appears in written records in China before the birth of Christ, at a time when the Chinese devices for indicating relative pitches were already sufficiently accurate to indicate the outline of the tune. Variants of this same tune are familiar to most of the 400,000,000 inhabitants of modern China, and therefore it is probably safe to say that this is the most popular song ever known.

In European music, the first great flowering of song of which ample records exist is that which took place in France around A.D. 1100. The troubadours in the south of France and the trouvères in the north were the aristocrats among professional musicians of this period. They were both composers and performers, usually attached to one or another of the great houses of western Europe. The names of many of these artists are still known, and hundreds of their compositions have survived, usually solo songs influenced by the melodic and rhythmic modes of the medieval church. At first these singers composed both words and music and played their own accompaniments; later, however, the functions of poet and musician separated. The troubadours had a popular counterpart in the jongleurs and *ménétriers,* or minstrels, who combined various kinds of acrobatics and juggling with their roles as traveling musicians. They were succeeded in central Europe by the minnesingers, who differed from the troubadours in their insistence upon singing their own verses and in their refusal to be paid for their songs. By the beginning of the fourteenth century, however, professional music in Germany was in the hands of the Meistersinger, middleclass guildsmen who flourished as feudalism began to decline. By this time, also, many of the songs, whose forms (ballade, rondeau, madrigal, etc.) were as numerous as those of poetry and were closely related to them in structure, were set down with indications for an accompaniment to the solo voice.

By the middle of the fifteenth century the composers of northern Europe were absorbed in the writing of polyphonic music, and lyrical solo songs seem to have been rare in cultivated musical circles for a hundred years. With the songs of the lutanists in sixteenth-century England and Spain, however, a great revival of song occurred which reached heights never surpassed in either country. Meanwhile, the movement in Italy which resulted, about 1600, in the first opera, was developing two distinct types of song, the recitative and the aria. The recitative was close to speech and was used to carry the plot forward wherever it was important to understand the words; the interest in the aria, on the other hand, lay chiefly in the melody. The former style had great influence on French music, as the aria did on Italian. These types of song also influenced vocal style, and thus in the nineteenth and twentieth centuries Italian singers were famous for a flowing style which emphasized great beauty of tone, whereas French singers had developed a quite different use of the voice, coloring the words with intonations of great expressiveness.

By the end of the eighteenth century, several influences in central Europe had combined to bring about the great period of German song. Up to this time, song accompaniments for keyboard instruments usually made use of the figured bass system, which defined the harmonies intended by the composer but left the detail of their arrangement on the keyboard and their progression from one harmony to another

to the performer. Now, however, composers began to interest themselves in a new type of accompaniment, which soon ceased to be designed simply for the occasional support of the singer. The improved fullness and sustained qualities of tone that accompanied the development of the piano made more interesting the composition of music specifically for the piano, and the result was a series of songs described as *durchkomponiert,* or through-composed; that is, the music was composed to fit the song all the way through, and though the melody for successive stanzas was usually the same, the accompaniment was intended to heighten the dramatic effect of the words and to be more nearly equal in importance to the voice. Songs written in this general style are called *Lieder.* The word *Lied* is simply the German for "song," but the term has come to mean a certain kind of comparatively dramatic song with piano accompaniment.

Some modern composers have experimented with a style called *Sprechgesang,* or "speech song," which may be described as a singing that resembles speech. There is also a new type of recitative that is occasionally heard, called *Sprechstimme,* or "speech voice," which is speech with a singing quality and differs from primitive chants chiefly in its wide melodic leaps. *See also* Music; Singing. H. Cow.

**SONGDO.** *See* Kaesŏng.

**SONG FORM,** in music, a loose though well-established designation for that three-part or A-B-A structure in which a complete section is repeated after a contrasting digression. Song form is so named because it represents a design frequently found in the art song, though the A-B-A design, one of the oldest and most fundamental designs in music, is equally common in instrumental music. It is the design, for example, of the minuet with trio, the scherzo with one trio, and, indeed, of most of the smaller forms popularized during the Romantic period: the étude, waltz, mazurka, polonaise, romance, and nocturne.

The first of the three sections of the song form may end with a full cadence or it may dissolve by degrees into the digression. The latter may offer a diametric contrast in style, meter, key, and texture, or it may simply present a new facet of the initial idea. Finally, the initial section may be repeated literally, or it may be altered by additions, deletions, or ornamental treatment. In a broad sense, sonata form is an extended elaboration of song form. W. S. N.

**SONGHAI.** *See* African Peoples.

**SONGKOI** or **COI RIVER** [sɔ′ŋkɔi′], a river also known as Red River, rising in the south central part of Yunan province of southwestern China. It flows almost a straight course, through what is thought to be a structural valley, southeastward across Tonkin, northern French Indochina, into the Gulf of Tonkin, a distance of about 500 mi. Hanoi, Indochina, is the principal city on the river.

J. E. F.

**SONG OF HIAWATHA.** *See* Hiawatha, The Song of.

**SONG OF ROLAND, THE.** *See* Chanson de Roland, La.

**SONG OF SOLOMON,** also called Song of Songs and Canticles, a book of the Old Testament, belonging to the division of Hagiographa (Sacred Writings). It is one of the five scrolls and is read in the synagogue during the Passover holiday.

The Song of Solomon is a rhapsodic poem, or a series of love poems, expressing the desire of a young woman for her lover and the young man's responding passion. From very early times, the work has been traditionally regarded as an allegory, representing the love between God and Israel, and in fact, the conception of the relationship between God and Israel as a marriage is expressed in the early prophetic books of the Old Testament. It was doubtless on the strength of this interpretation and its ascription to the authorship of Solomon that the book gained admission to the canon; even so it was the subject of considerable dispute, some sages, while not denying that the work was allegorical, holding that its highly erotic character might prove a pitfall for unlearned readers. The Christian Church has similarly interpreted the Song of Songs symbolically, seeing it as a prophetic representation of the love between Christ and the Church.

Most modern critics hold that the poem is just what it appears to be—a glorification of earthly love. Even literally interpreted, however, the book presents many problems, and a number of explanatory theories have been advanced. While it is evident that the lines are spoken by more than one person, it is not certain how many persons are involved or what situation is depicted. Many critics see the work as a drama, and among the interpretations offered are the following: a young shepherd and shepherdess find fulfillment in married love; the king falls in love with a shepherd girl, but she remains faithful to her shepherd and is ultimately united with him; the king falls in love with a humble shepherd girl and elevates her to the position of queen. Those who do not regard the king as a participant in the action, explain the references to him on the basis of the oriental convention of calling a bridegroom a king. A theory which has gained ground in recent times is that the Song of Songs is a series of wedding songs sung at the celebration of a marriage feast; this removes the difficulty raised by the lack of continuity.

Whatever interpretation of the Song of Songs is accepted, the work is notable for its depth of passion and vivid sensualism, its effective imagery in which love is intimately associated with the beauties of nature, and its many exquisite phrases which have widely influenced language and literature. A notable Hebrew Sabbath hymn, for example, in which the Sabbath is likened to a bride, uses as a refrain the phrase *Lecha dodi* ("come, my beloved," vii:11).

It was formerly supposed by scholars that the Song of Solomon was, if not Solomonic, at least very early in date, but most critics have come to believe, on the basis of linguistic evidence, that it is of a comparatively late date; a precise date, however, has not been established. Some see in the work the evidence of Greek influence; this would suggest a date in the third or second century B.C. D. G. and G. W.

**SONG OF THE THREE HOLY CHILDREN, THE,** an Apocryphal book, consisting of three sections: The Prayer of Azarias, a brief narrative passage, and The Hymn of the Three. It is found only in the Greek Bible, and versions based upon it, but some scholars believe that it was originally written in Hebrew. In the versions in which it appears, the work, constituting an addition to the Book of Daniel, is inserted after iii:23 in that book. The Prayer purports to be a plea for deliverance from the fiery furnace into which Azarias or Azariah (Abednego) and his two companions, Hananiah (Shadrach) and Meshael (Meshach) have been cast by Nebuchadnezzar's orders; the narrative passage tells of the descent of an angel who delivers the three by cooling the center of the furnace; and the Hymn is the thanksgiving ode of the three.

It has been pointed out that both the Prayer and the Hymn seem unsuited to the situation: the first is a confession of national sin, an acknowledgment of the justice of the punishment, and a complaint of its bitterness; the second is a doxology, couched in general terms and closely resembling Psalm cxlviii, calling on all natural phenomena to join in the praise of the Lord. Accordingly scholars hold that the Prayer and the Hymn were never an organic part of the Book of Daniel, but that these, as well as the narrative passage, were later interpolated in a desire to expand the popular Daniel story. Internal evidence in the Prayer suggests the difficult period of the Maccabean revolt as the time of composition (c. 167 B.C.); the Hymn was probably composed some time later when conditions were improved. D. G. and G. W.

**SONNECK, OSCAR GEORGE THEODORE** [sa′-nɛk] (1873-1928), pioneer American musicologist, and first chief of the music division of the Library of Congress (Washington, D.C.), was born Oct. 6, 1873, at Jersey City, N.J. After a German education he returned to this country and began the researches in early American music which resulted in his many publications. *Early Concert Life in America* (1907), *Early Opera in America* (1915), and other studies by Sonneck painted for the first time a balanced and detailed picture of musical life in America before 1800. Appointed in 1902 to head the newly-organized music division of the Library of Congress, he created within the space of fifteen years one of the foremost music libraries of the world. In 1915 he founded and assumed editorship of *The Musical Quarterly,* America's first musicological journal, and from 1917 until his death he was a director of the music publishing firm of G. Schirmer, Inc. He died Oct. 30, 1928, in New York City. W. Li.

**SONNET,** a poem composed normally of fourteen lines of iambic pentameter rhymed according to a traditional scheme. The exact origin of the form is obscure, but it was well known in Italy in the thirteenth century and since that time has attained wide and permanent popularity in all the Western European literatures. Different groupings of the lines and different rhyme schemes have produced several distinct forms, of which two are common in English, although poets frequently experiment with variations.

Of the two standard patterns, the "Italian" or "Petrarchan" sonnet produces the more serene effect, one that is well illustrated in Wordsworth's *Westminster Bridge:*

> Earth has not anything to show more fair:
> Dull would he be of soul who could pass by
> A sight so touching in its majesty:
> This city now doth, like a garment, wear
> The beauty of the morning; silent, bare,
> Ships, towers, domes, theatres, and temples lie
> Open unto the fields, and to the sky;
> All bright and glittering in the smokeless air.
> Never did sun more beautifully steep
> In his first splendour, valley, rock, or hill;
> Ne'er saw I, never felt, a calm so deep!
> The river glideth at his own sweet will:
> Dear God! the very houses seem asleep;
> And all that mighty heart is lying still!

In the Italian sonnet the lines are arranged in two groups: the first group (the octave) contains eight lines closely knit together by the rhyme scheme *abbaabba;* the second group (the sestet) contains the six remaining lines in a rhyme scheme that is commonly *cdecde,* although many variations, especially *cdcdcd* as above, are used. The Italian sonnet is particularly appropriate for philosophic poems and for eloquent love poems; its natural pause after the octave makes it a logical form for the expression of two closely related ideas. In the best Italian sonnets, the rhythm normally builds to a climax at the end of the octave, and dies away to silence in the closing lines of the sestet.

The other common form is the "English" or "Shakespearean" sonnet:

> That time of year thou mayst in me behold
> When yellow leaves, or none, or few, do hang
> Upon those boughs which shake against the cold,
> Bare ruin'd choirs where late the sweet birds sang.
> In me thou see'st the twilight of such day
> As after sunset fadeth in the west,
> Which by and by black night doth take away,
> Death's second self, that seals up all in rest.
> In me thou see'st the glowing of such fire
> That on the ashes of his youth doth lie,
> As the death-bed whereon it must expire,
> Consum'd with that which it was nourish'd by.
> This thou perceiv'st, which makes thy love more strong,
> To love that well which thou must leave ere long.

Here the fourteen lines are treated as three quatrains and a couplet, so that the form lends itself particularly to the expression of three closely related ideas about the same theme, with a brief concluding statement. The rhyme scheme accentuates this grouping, being *abab cdcd efef gg.* Characteristically, there is a slight pause at the end of each quatrain, so that the rhythm does not have the single rise and fall that is heard in the Italian sonnet. Shakespeare is the great master of the English sonnet, a form that has continued to attract most serious poets since his time.

The sonnet sequence or cycle is a group of sonnets developing one central theme, usually love, and published as a unit. After Petrarch's great model (*Sonnets to Laura*) many cycles have been produced, the fashion having been particularly popular in English. The best-known examples are Platen's *Sonnette aus Venedig* (in German), Spenser's *Amoretti,* Sidney's *Astrophel and Stella,* Samuel Daniel's *Delia,* Shakespeare's *Sonnets,* Elizabeth Barrett Browning's *Sonnets from the Portuguese,* Dante Gabriel Rossetti's *House of Life,* and, in America, Edna St. Vincent Millay's *Fatal Interview* and William Ellery Leonard's *Two Lives.* R. Bn.

**SONORA** [sono′rə], a mountain pass 9,624 ft. high, located in Tuolumne Co. in the Sierra Nevadas of eastern California. It received its name from the near-by town of Sonora, which was a central point on the wagon trail used by the early explorers, miners, and immigrants in reaching the San Joaquin Valley. The pass, which was first used for the gold rush in 1853, was of major importance as a Sierra crossing during the 1860's. A. L. R.

**SONS AND LOVERS,** a vivid and poetically written autobiographical novel by D. H. Lawrence, first published in 1913. Composed before the study of modern abnormal psychology had reached an advanced stage, it constitutes, nevertheless, a classic literary investigation into the disastrous effect of an exaggerated emotional attachment between mother and son. Suffering from the effects of an unhappy marriage and the drabness of a poverty-ridden life in a coal-mining village, Mrs. Morel is driven to seek compensation for the disappointments of her own life in her influence upon her younger son, Paul, who finds this influence an unsurmountable barrier in his attempts to approach other women, whether spiritually or passionately. Only his mother's death frees him to make his own long-belated adjustment to the world and to himself. C. E. M.

**SONS OF LIBERTY,** the name of two underground political organizations which operated at different periods in American history.

1. The first Sons of Liberty was an intercolonial secret organization of the more radical groups in the American colonies after 1763. It appeared openly at the time of the Stamp Act. Its members helped lead the successful effort to force the stamp agents to resign in Boston and in New York. In the following years they were effective in forcing nonimportation agreements on American merchants. Sons of Liberty in the various colonies maintained contact by means of messengers. From time to time they took joint action against British measures. The organization appears to have been led by merchants, lawyers, and politicians, but included the masses of mechanics and artisans in the colonial towns. The masses sometimes got out of hand, rioted, and destroyed property. In 1765 the residence of Chief Justice Thomas Hutchinson in Boston was destroyed. In New York City houses of British officials were attacked, taverns were raided, and general riots followed. These violent methods alienated many merchants and other members, but there remained a small, well-organized group of leaders. This unit provided a solid basis for the revolutionary movement, which grew rapidly after the passage of the "Intolerable Acts" in 1774.

2. The second Sons of Liberty, a Copperhead order, was formed in 1864 during the Civil War as a result of the reorganization of the Order of the American Knights. C. L. Vallandigham of Ohio, then in exile in Canada, was the Supreme Commander. The order, at one time claiming a membership of 300,000, was organized to work for peace. Members were sworn to oppose the confiscation acts of the Federal Government and to support states' rights principles. They opposed the draft and discouraged enlistments in the Northern armies. Confederate agents in Canada used the order without success to promote a northwestern confederacy outside the Union. Six of its members were arrested and tried for treason, and three were condemned to death, but were never executed. M. Je.

**SONS OF THE AMERICAN REVOLUTION, THE NATIONAL SOCIETY OF.** *See* Societies, Associations, and Organizations.

**SONSONATE** [sɔ′nsonɑ′te], capital of the department of the same name, situated about 50 mi. from San Salvador and 12 mi. from Acajutla, near the volcano of Izalco, in El Salvador. It is the center of a rich agricultural district, which produces sugar, coffee, corn, tobacco, and balsam. Pop. 1950, 17,949. S. G. I.

**SOOCHOW (WUHSIEN)** [su′jo′, wu′shɪɛ′n], a city in the southern part of the Province of Kiangsu of central eastern China, to the east of Tai Lake, at 31° 15′ N. lat. and 120° 32′ E. long. Soochow is situated on the level, low-lying Yangtze delta, about 50 mi. west of Shanghai, although the Yangtze itself is 20 mi. north of Soochow. Near the city the Grand Canal takes a sharp turn toward the south, extending another 200 mi. down to Hangchow in Chekiang Province. Surrounded by a wall and a moat 12 mi. in circumference, Soochow was the capital of the local Kingdom of Wu about 600 B.C.—not to be confused with the later Kingdom of Wu (A.D. 222-280)—hence the alternate name Wuhsien. It was during the Sui Dynasty (A.D. 589-618) that the city was first known as Soochow.

Scores of canals cut through Soochow and in many cases take the place of streets, though many now have either been filled in or replaced by streets. Many of the ancient marble and carved stone bridges seen by Marco Polo, who counted 6,000 of them, are no longer in existence. The Tiger Hill Pagoda, built in A.D. 601 and rebuilt in 1438, is now in danger of collapse. The 1,000-year-old Taoist shrine, Shuen Miao Kwan, has now become a market place, but is still held sacred by Taoists. The Pao Tai Chiao, or the Precious Belt Bridge, 12,000 ft. long, which spans a stream connecting the Grand Canal with the Tai Hu or Great Lake, was built in the ninth century by a local official. In Soochow is Soochow (Tungwu) University, which is noted for its law school.

The climate of Soochow is warm and humid for much of the year, the average temperature being about 60° F.; June, July, and August average about 80° F. with a maximum temperature of 105° F. The three winter months of December, January, and February average about 38° F. Soochow has from 45 to 50 in. of rainfall annually, fairly evenly distributed but with a maximum of from 6 to 7 in. in June and July.

The area surrounding Soochow is thickly populated. A variety of agricultural products such as rice, cotton, beans, mulberry trees, wheat, tea, and vegetables are grown. There are food-processing establishments and textile mills in Soochow, the most important products being tea, cotton, and silk. Soochow is said to produce both the best rice and the best silk in China. The most important industry of the city is silk reeling. There are about 4,000 hand looms in operation, producing the finest brocade and silk gauze. Excellent embroideries, known as "Ku Hsiu" as distinguished from the "Hsiang Hsiu" of Changsha, are also produced in large quantities. Other important occupations are jade stone-cutting and grinding natural crystals into spectacle lenses. Soochow is on the Shanghai-Nanking Railway. Pop. (est. 1947), 260,000. A. C. T.

**SOONG, T. V. (SUNG TSE-VEN)** [sʊ′ŋ] (1891- ), Chinese banker and politician, was born in Shanghai in 1891. He was one of six children of an influential Chinese family; three sisters were married to Sun Yat-sen, Chiang Kai-shek, and H. H. Kung. Soong had his early schooling in Shanghai, then graduated from Harvard University and received a doctorate from Columbia University. After working in New York banking houses he returned to China in 1917 and rose rapidly in banking and politics. He was secretary of the Canton government in 1923, president of the Canton Central Bank in 1924, and minister of finance in the Nationalist government from 1925 to 1933. In 1933, for the first time in modern Chinese history, Soong balanced the country's budget without recourse to foreign loans. He unified the currency, abolished domestic tariffs, established central banking, and introduced other Western financial reforms. He founded the Bank of China and became its chairman in 1935. Soong was appointed minister of foreign affairs in 1941, and in 1944 he became acting premier and president of the Executive Yuan, second in importance only to Generalissimo Chiang Kai-shek. On May 31, 1945, he succeeded to the premiership when Chiang resigned in order to devote himself to other duties, remaining in that post until February 1947. After the Communist victory in the Chinese civil war, Soong arrived in the United States. He later went to Paris. On June 16, 1950, Chiang Kai-shek ousted both T. V. Soong and Dr. H. H. Kung as bank directors. Soong returned to the United States in July 1950. G. Q.

**SOPHISTS** [sɒ′fɪsts], a term originally denoting "men of wisdom." During the second half of the fifth century B.C.

the term came to be applied to the professional teachers in Greece who traveled about giving instruction in the arts of rhetoric, oratory, and the conduct of public affairs. The name gradually became a term of reproach, partly because the sophists took pay and partly because the radicalism of some of the later sophists scandalized the conservatives. Contrary to the traditional view, the sophists were not a clearly defined school or sect, with a recognized or common type of philosophical doctrine. They were characterized more by their mode of thought than by any fixed content of thought. However, though they made no pretense of being philosophers, their influence on philosophy, as well as on politics and ethics, was considerable; and their stress on dialectic, grammar, rhetoric, and oratory was of lasting value in the field of literary education.

In the history of philosophy the sophists mark the end of the era which preceded Socrates, but in actual fact they belonged neither to the pre-Socratic era of the Atomistic, Heraclitean, and Eleatic schools, nor to the later era of Socratic idealism. They represent, more correctly, a short pause in the development of philosophy, during which all Greek traditions and beliefs fell prey to the critical spirit of the age, and the stage was cleared for the second great period in Greek philosophical thought, which reached its highest development in Socrates, Plato, and Aristotle.

Sophistic skepticism was the outcome of a complex mixture of influences which shaped the social, political, philosophical, and religious conditions of Athens during the latter half of the 5th century B.C. The sophists sprang up as the result of a clear demand for a certain kind of culture, especially in the art of public speaking, proficiency in which, with the rise of Athenian democracy, became of paramount importance for those seeking success in civic affairs. This emphasis on worldly success tended to corrupt, and the later sophists became increasingly unscrupulous, setting no value on objective truth, making the worse seem the better cause, and teaching their pupils only how to win at all costs and by whatsoever means. However, no reproach of the sort was ever attached to the two leading philosophers of the sophistic age, Protagoras and Gorgias, though their doctrines led inevitably to moral, philosophical, and intellectual decay. Protagoras of Abdera (c. 480-411 B.C.), in the famous phrase attributed to him—"Man is the measure of all things"—denied objective truth and reduced knowledge to individual opinion, thus laying the foundation of the eristic method of dispute and, by making the subjective element everything in knowledge, turning attention from external nature to man himself. Gorgias of Leontini, a contemporary of Protagoras, proved by the use of dialectical reasoning that nothing exists, that even if it did exist it could not be known, and that if it could be known it could never be communicated, thus carrying the skepticism of Protagoras to nihilism. Hippias of Elis, the versatile rhetorician, and Prodicus of Ceos, the moralist, exemplified the logical limits of eristic and moral sophistry, the attempts of the latter to formulate moral precepts breaking down under skepticism, for, where truth is relative, laws become meaningless.

From this theoretical skepticism, in which the individual was a law unto himself in matters of knowledge, the step was not far to ethical skepticism and the view that man was a law unto himself in matters of conduct. It was left to the younger and more radical of the sophists—men like Polus, Thrasymachus, and Euthydemus—to draw these consequences. Morality became mere convention, the rules of morals were considered contrary to nature, and natural right was consequently the right of the stronger. Independence of thought had thus degenerated into intellectual and moral anarchy, and individualism into pure selfishness.

However, despite the inability of the sophists to employ the instruments of reason towards a constructive philosophy, their criticism of knowledge and morality focused attention on the fallacies and weaknesses of hitherto accepted standards and beliefs. The great value of the sophistic movement was that it wakened thought and challenged philosophy, religion, custom, morals, and the institutions based on them, to justify themselves to reason. And this was the challenge that Socrates (also classed as a sophist though he did not teach for pay) took up, meeting the threat of materialism and skepticism to the intellectual and moral life of the nation by determining the conditions of intellectual knowledge and by laying a deep systematic foundation for ethics. C. W. D.

**SOPHOCLES** [sɒ'fəkliz] (c. 495-406 B.C.), Athenian dramatic poet, was born sometime in the period 497-494 B.C., the son of a wealthy manufacturer, Sophillus, who lived in the district of Colonus about a mile northwest of Athens. As a boy, Sophocles received an education which emphasized thorough training in music, dancing, and gymnastics. He was pre-eminent in all of these and was noted for his grace and handsome appearance. Tradition has it that after the Greek victory over the Persians at Salamis in 480, he was chosen leader of the chorus of boys selected to sing the victory song. While still in his twenties (468 B.C.), he won first prize in the tragic contests in competition against Aeschylus, and from then on throughout more than sixty years of productivity his literary career was one of exceptional success. During this period he was also elected by the people to a number of important political offices. In 440 he was chosen along with Pericles as one of the ten generals of the state *(strategoi)*, one of the highest offices in public life. This and similar honors came to him probably because of his popularity as a tragic poet and not because of any particular aptitude for political affairs. He was active, too, in religious offices and seems to have performed certain priestly functions connected with the cult of Asclepius. He was regarded by the people as a favorite of the gods and was accorded a number of religious honors. Sophocles was so fond of his fellow citizens and his city that although he was invited to the courts of many rulers, he stayed in Athens throughout his life. And after his death the Athenians appear to have worshipped him as a semidivine hero under the name Dexion and to have built him a shrine at which they sacrificed yearly.

Of Sophocles' private life it is known that he married a woman named Nicostrate and by her had a son, Iophon, who himself wrote tragedies. He also was reputed to have had a son Ariston by a certain Theoris of Sicyon. Three other sons are named by one ancient source but nothing else is known about them. Sophocles died in the fall of 406. His career coincided with the birth, maturity, and decay of the greatness of Athens and its empire. In the midst of one of the most eventful periods of human history, he seems to have led a tranquil life of prosperity, universally admired as a man and as an artist.

**Works.** Sophocles composed some one hundred and twenty dramas, of which the titles of one hundred and fourteen are known. Most of them were produced at public religious festivals at Athens in groups of four plays on unrelated themes, trilogies of tragedies plus single satyr-plays, in competition with similar groups by Aeschylus, Euripides, and other poets. Sophocles won over twenty first prizes, more than any other Greek dramatist, and was never awarded less than second prize. Early in the Christian era seven of his

plays were selected by scholars as specimens for school study and these are the only ones which have survived. We possess no tragedies dating from the first half of his literary career; those that are extant date between his fiftieth and ninetieth years. They are: *Antigone* (probably 442 or 441), *Philoctetes* (409), *Oedipus at Colonus* (402, the date of its posthumous presentation), and, of uncertain date, *Ajax, Oedipus Tyrannus, Trachiniae,* and *Electra.*

SOPHOCLES

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**Technique.** Tragedy suffered no basic alterations of form in the hands of Sophocles. It remained essentially what it was with Aeschylus, a highly complex art form combining metrically phrased speech, music, dance, and intricately metered song. According to ancient testimony, however, certain innovations were made by Sophocles. The more important of these were: (1) The introduction of the third actor, a change leading to greater flexibility and liveliness of dialogue, to fuller delineation of character, and to greater complexity of plot, as well as to a reduction of the importance of the chorus; (2) the use in the standard tragic trilogy of three separate plays with unrelated themes instead of three based on one theme as in Aeschylus' *Oresteia;* (3) development in the use of painted scenery; and (4) the increase of the chorus from twelve to fifteen members.

Sophocles' greatness, however, consisted not in his inventions but in his gradual perfection of the form which he had inherited. At the height of his productive career he became an unparalleled craftsman, particularly in his construction of plot and portrayal of character. Working in the same restricted area of mythical tradition as his predecessors, he broadened the scope of tragedy by bringing it down from its supernatural heights to the level, not of common man to be sure, but of heroic man idealized. He did not neglect the great moral and religious problems handled by Aeschylus but he did not permit them to obscure the human interest of his stories. He made them the background against which the human characters moved. He enriched the legends with a variety of incidents and motives skillfully interwoven and secured verisimilitude by relegating what was implausible to the antecedents of the plot. The course of events in his plays was natural; scenes and events were joined with smoothness and ease, and he took especial pains in motivating the entrances and exits of the players. With all his striving for harmonious structure, Sophocles' principal object was representation of human nature in action. He desired to make his hearers concentrate their attention upon the ethical and moral meanings of certain situations and actions and upon the character of the human agents. Thus his characterizations lay midway between the sketches of Aeschylus, drawn with a few bold and decisive strokes, and the comparatively intricate psychological portraits of Euripides.

Sophocles made particularly effective use of dramatic irony, and "Sophoclean irony" has become proverbial. It was of two kinds, verbal irony and irony of situation or destiny. Verbal irony itself was of two types. In one type the speaker, foreseeing the doom that was to come to another, grimly rejoiced in the prospect, using ambiguous language understood by the audience but not by the victim. The dialogue between Electra and Aegisthus at the close of *Electra* is a good example. In the other type, either an observer of the action, ignorant of the true state of affairs, or the unknowing victim himself was the speaker of double-edged phrases open to an interpretation quite different from his intended meaning. *Oedipus Tyrannus* is a perfect example of this type as well as of irony of situation.

**Thought.** Combining Aeschylean elevation of thought with the psychological insight of Euripides, Sophocles stood as a mean between these two poets. His plays dealt with serious and universal problems, for many of which he proffered no sure solution. His main concern was with man, his position in the world, his potentialities for good and evil, and his relation to the gods. The leading characters of Sophoclean tragedy were human beings cast in the heroic mold and the plots were designed to reveal their personalities. Both ancient and modern critics have admired Sophocles as a superb painter of such human characters. His portraits, however, were more than mere artistic studies; they were searching examinations of human ideals, of human values, and of the meaning of a human life that was subject to strict control by the gods. These gods were figures of the popular religion who had come down essentially unchanged through literature and cult from the time of Homer. It has been said that Sophocles accepted these conventional deities without qualification and without question. This is an oversimplification. Certainly he did not analyze them or attempt to determine the nature of the divine; he had no new theology, he did not try to justify the ways of god to man, he was no zealous reformer or preacher. Yet his conception of the divine and its role in human affairs was clear and positive. For him the gods were omnipotent and omniscient figures, inscrutable to humans and working for mysterious ends which were often incomprehensible, yet deserving unquestioning reverence; their laws could not be transgressed with impunity. They assigned man his lot, which was his to bear; within the limits which they set upon his action he was a free and responsible agent possessing dignity and worth; outside of them, his actions became immoderate and likely to create the tragic situation. The essence of this Sophoclean view of life can be found most wonderfully expressed in two magnificent choral odes, one on the eternal divine laws in *Oedipus Tyrannus* (ll. 863-910), the other on the wonders of man in *Antigone* (ll. 332-367). In these and others of his plays it can be seen how, with expert stagecraft and supreme mastery of the poetic art, Sophocles blended perfect form with an exalted and comprehensive interpretation of life. This was his genius. The achievement has been rarely matched in literature. *See also* AJAX; ANTIGONE; ELECTRA; OEDIPUS AT COLONUS; OEDIPUS TYRANNUS; PHILOCTETES; TRACHINIAE. S. D. At.

**SOPHRON** [so'frŏn], Greek playwright of Syracuse of the fifth century B.C., the inventor of the ancient literary genre called the mime, a short, quasi-dramatic sketch exhibiting realistic scenes from daily life. Sophron probably took as

his models certain early, popular dramatic skits and elevated them into a literary form; although he himself wrote in prose, it was perhaps consciously rhythmical, and later literary mimes are in verse. Sophron's works, now lost, were greatly admired by Plato, who was said to have kept the mimes of Sophron under his pillow and used them as models for his early Socratic dialogues. Some idea of the nature of Sophron's works may be gained from later imitations and adaptations: the second and fifteenth idylls of Theocritus and the fourth mime of Herodas are said to have been derived from them. Dramatic mime, which was very popular in Rome and almost drove all other dramatic forms from the stage, was another offshoot of the early, subliterary dramatic skits of the Dorian Greeks, especially of the so-called Phlyax Comedy of Sicily and South Italy. *See also* HERODAS. C. T. M.

**SOPRANO** [sopra′no], a term in music for voices in the highest range, extending upward for about two octaves from about middle C. Sopranos include not only the higher female voices but also boy sopranos, with unchanged voices, and male sopranos, either *castrati* or falsetto singers. Female sopranos are commonly classed as lyric when they are straight singers of songs and ordinary choral music, dramatic when they are concerned with operatic roles requiring greater power and depth of tone, and coloratura when they are practiced in the florid arias of eighteenth- and nineteenth-century opera and oratorio. In four-part writing, either choral or otherwise, the highest part is called "soprano," and the term also designates the highest or next-highest members of the trombone, saxophone, or other instrumental families. In the saxophone, sarrusophone, and similar instrumental families developed during the nineteenth century, the very highest instrument, which is usually pitched in E-flat, a fourth higher than the B-flat soprano, is called "sopranino."

The term "mezzo soprano" is used to designate a female voice between soprano and alto in pitch. W. Li.

**SOPRON** (Ger., **ÖDENBURG**) [sho′pron ö′dənburχ], capital of the ancient *comitat de Sapron,* located 6 mi. west of the south end of Neusiedler Lake in northwestern Hungary. It is an Austro-German city around which the Hungarian boundary was placed after the 1921 plebiscite. Sopron is a market town serving a grain and grazing region in the foothills. The first established college of mining and forestry in Europe is located in Sopron. Raiding, the Franz Liszt birthplace, is near by. Pop. (off. est. 1948), 42,255. H. J. R.

**SOPWITH, THOMAS** (1803-1879), English mining engineer, was born in Newcastle-on-Tyne on Jan. 3, 1803. He was the son of a cabinet-maker, and when his education at private schools in Gateshead and Newcastle was completed he was apprenticed to his father. He proved apt at drawing and began to show considerable interest in surveying and mining. In 1822 he submitted plans and drawings for a new prison in Newcastle and two years later received his father's consent to leave the family business in order to take a position as assistant to a mining and land surveyor, whose partner he later became. His work was varied and diffuse, including church plans, mine studies, and road surveys. He frequently addressed technical societies and wrote numerous papers, of which the most important are *On the Construction and Use of Geological Models in Connection with Civil Engineering,* for which he received the Telford Medal in 1841; *The National Importance of Preserving Mining Records* in 1844; and *On the Practical Importance of Geology* in 1859. He was elected a Fellow of the Royal Society in 1845 and was also a member of the Meteorological Society, of which he was president from 1859 to 1861. Sopwith enjoyed travel and in 1857 published an account of one of the most extensive of his journeys: *Notes of a Visit to Egypt, via Paris, Nîmes, Marseilles and Toulon.* He was much concerned with the welfare of the miners whom he supervised, and during his twenty-six years as mine agent he introduced many reforms, both in sanitation and educational facilities. He died Jan. 16, 1879, in London. S. M. M.

**SORATA.** *See* ILLAMPÚ.

**SORBIAN** [sɔ′rbiən], also called Wendish, especially by the Germans, and Lusatian Serb, a Western Slavic dialect now spoken in the upper valley of the Spree, formerly belonging in part to Prussia and in part to Saxony; as late as the sixteenth century it occupied practically all of Lusatia. Sorbian is the only living remainder of that vast mass of Slavic population which once occupied the whole of Eastern Germany up to the Elbe and even beyond. It is divided into two geographically separated and widely different dialects, Upper Sorbian to the South and Lower Sorbian to the North; it is spoken by 70,000 to 120,000 persons. It is in some respects a very conservative language, preserving the dual and the Slavic imperfect and aorist. It shows some connections with Polish on one side, having the treatment *trot* of the *tort* groups where Czech has *trat,* and with Czech on the other, since the Sorbian accent is fixed on the first syllable. The oldest Sorbian literary text is a translation of the New Testament in Lower Sorbian (1548). Since the Romantic period, a national movement favored by the Czechs and Poles has developed among the Sorbs. G. B.

**SORBONNE.** *See* PARIS, UNIVERSITY OF.
**SORBOSE.** *See* SUGAR CHEMISTRY.

**SORDELLO** [sɔrdɛ′lo], a poem in six books by Robert Browning, written in four periods over seven years, and published in 1840. Its purpose was to show the "development of a soul," and its vehicle was the legendary career of Sordello, the troubadour poet of Dante's *Purgatorio.* Like *Paracelsus, Sordello* is concerned with love, aspiration, defeat, triumph, and death, and owes more to Shelley and young Browning than to history. The poem is not carefully finished, and remains a potpourri of romance, psychology, and philosophy, with magnificent poetic interludes. Incomprehensible to reviewers, *Sordello* blighted Browning's reputation for 25 years. W. C. De V.

**SOREL, ALBERT** [sɔ′rɛ′l] (1842-1906), French historian and public official, was born in Honfleur, Normandy, Aug. 13, 1842. His masterpiece, *L'Europe et la révolution française* (8 vols., 1885-1904), corrected the earlier studies of Heinrich von Sybel and has remained a standard work on the international aspects of the French Revolution. Sorel interpreted the wars of the Revolution and Napoleon as a continuation of Louis XIV's expansion in quest of natural frontiers. In addition to his career as a historian, Sorel taught diplomatic history at the École Libre des Sciences Politiques and served in the French foreign office from 1866 to 1875. In 1875 Sorel became general secretary to the president of the senate, which gave him both income and leisure to carry on his historical research and writing. He was elected to the French Academy in 1894, and the Prix Osiris of 100,000 francs was awarded to him shortly before his death in Paris, June 29, 1906. R. M. Br.

**SOREL, GEORGES** (1847-1922), French engineer and social philosopher, was born in Cherbourg on Nov. 2, 1847. He was educated at the École Polytechnique and for twenty-five years was an engineer with the Department of Bridges and Highways. Becoming interested in revolutionary socialism, however, he resigned in 1872 and devoted himself to study and writing. Influenced by Proudhon, Marx, and Nietzsche, he helped to launch the syndicalist movement in France, acting as theoretician for the movement. Essentially a moralist rather than an economist or philosopher, Sorel was an anti-intellectual, anti-parliamentarian pessimist, whose revolutionary fervor was more authoritarian than it was humanitarian or consistent. He attack the faith in progress characteristic of the democratic optimism of the nineteenth century and posited the "myth of a general strike" and the "primacy of violence" as the rather cynical means toward revolutionary action. Largely on the basis of *Reflexions sur la violence* (1908), his best-known book, he has been credited with having had an influence on Mussolini and the rise of fascism, but his ideas lacked sufficient cohesiveness to have been of much importance. He died in Boulogne-sur-Seine on Aug. 30, 1922. C. W. D.

**SOREL** [sɔ′rɛ′l], a port city and the county town of Richelieu Co., Quebec, Canada, situated at the confluence of the Richelieu and St. Lawrence rivers, 43 mi. northeast of Montreal. It is located on Highways 3 and 21 and is served by the Canadian National Railways. Named for a Captain de Saurel who commanded the first French fort built on the site in 1665, it was incorporated as a city in 1889. An important port with extensive wharves and grain elevators, it is also a manufacturing center with shipyards, steel works, armament plants, a sawmill, and clothing factories. Pop. 1951, 14,961. D. F. P.

**SORGHUM** [sɔ′rgəm], *Sorghum vulgare,* a member of the grass family having many varieties of economic importance. It is a tall, strong, erect annual, much like Indian corn. Although believed to be a native of Africa, its origin has never been determined, but since very ancient times it has been a staple food for enormous populations in warm regions such as China and Egypt. In the many centuries of cultivation numerous valuable varieties have been developed which comprise four classes: (1) the saccharin sorghum with sweet, juicy pith, grown for fodder and syrup-making; (2) the grain sorghums grown for their starchy seeds, used for food and to some extent for fodder; (3) broomcorn sorghums whose long stiff rays of the flowering panicle are used for brooms; (4) the grass sorghums which include Sudan grass and are usually associated with the grasses. Climate often determines which of these classes are grown. From Kentucky and Missouri southward, sugar sorghum, var. *saccharatum,* is grown for syrup. Sorgo is another syrup variety. More than 40 types of grain sorghums are in cultivation in the United States, grown chiefly as forage and food for stock and poultry. They include chicken corn, var. *drummondii,* developed in Guinea; durra, var. *durra,* coming from the Nile valley and including forms known as yellow milo, Jerusalem corn, and Egyptian rice-corn; feterita, var. *caudatum,* of Central Africa, with several other varieties, both standard and dwarf, grown in Texas; milo and shallu, var. *roxburghii,* of India and Africa. *See also* Broom Corn. C. K. H.

**SORIA** [so′ryɑ], the province and the capital city of that province, in northeastern Old Castile, in north central Spain.

**The City.** The smallest of the Spanish provincial capitals, Soria is situated south of the Sierra Cebollera, on the upper Duero River, about 115 mi. northeast of Madrid. In the past Soria was important for its control over one of the principal routes from Aragon to Old Castile. This position was injured by the building of railways that passed it by so that Soria lies in an economic backwater in a generally backward region. Its chief function is as a local administrative and educational center and as a market place. Its industries are varied but small. Soria is on branch railway lines and is served by several regional highways. Despite its smallness, Soria is of considerable interest for its old buildings and monuments, its picturesque and narrow streets, as well as its *plazas* and *paseos.* The principal edifices include a number of churches, such as those of Santo Domingo and San Pedro (collegiate). The outward aspect of Soria has not changed markedly since late medieval times, and sections of the thirteenth-century walls remain.

Three miles north of the city, at the confluence of the Tera and the Duero rivers, lie the ruins of Numantia, an ancient town of Iberian origin that long resisted Roman conquest and later acquired importance under the Roman Empire. During the rise of Castile in the twelfth and thirteenth centuries, Soria was rebuilt and fortified. It played a minor role in the intra-peninsular wars and family quarrels that have marked Spanish history. Soria was the seat of a department during the Napoleonic era. Under the Restoration it continued as capital of a province, of which the boundaries were fixed in 1833. Pop. 1947, 15,425.

**The Province.** The province, which has an area of 3,977 sq. mi., corresponds roughly to the upper end of the Duero basin, though two small sections extend across the divide into the upper Ebro watershed. The terrain around the northern, eastern, and southern edges is generally mountainous, being bounded by the Sierra Cebollera, the Sierra del Moncayo, and the Sierra de Guadarrama, respectively. Elsewhere is part of the central plateau, or *meseta.* Nearly three fourths of the area lies more than 4,000 ft. above sea level. The climate is continental with long, cold winters and hot summers. Precipitation is scanty, ranging in the vicinity of 20 to 25 in. and usually falling only a few days a year. The population has been virtually stationary since the end of the nineteenth century because of heavy emigration to New Castile and overseas, primarily to Argentina. Soria is the most sparsely populated province in Spain, with a population of about 40 per sq. mi. The economy is essentially agricultural and pastoral, and methods are primitive. There are a few mineral deposits, but because of the lack of transportation these have been exploited only in small part. Pop. (off. est. 1947), 162,218. R. G. W.

**SORITES.** *See* Logic.

**SOROLLA Y BASTIDA, JOAQUIN** [soro′lyɑ i basti′-thɑ] (1863-1923), Spanish painter and illustrator, was born in Valencia, Feb. 27, 1863. He entered the Academy in Valencia at the age of fifteen and in 1884 won second prize at the Madrid Exposition. Next year he went to Rome on a scholarship, later visiting Paris, where he admired the works of Jules Bastien-Lepage and Adolph Menzel. He also became familiar with the work of the French Impressionists. Sorolla attained public recognition in the 1890's, and from then until his death he was internationally known.

His great output of painting embraces the life of the people of Spain, landscapes, seascapes, and portraits. He painted steadily throughout his career, and, using the direct, informal technique of the Impressionists, he could paint

rapidly. He was interested principally in recording the instantaneous effect of figures or objects as they appeared in strong sunlight and shadow. Many of his characteristic works of children romping on the beach are in the collections

JOAQUIN SOROLLA Y BASTIDA

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of major museums. In 1919 he became professor of painting at the Academy in Madrid. Sorolla died in Madrid, Aug. 11, 1923. G. D.

**SORORITY.** *See* FRATERNITY.

**SORREL, HETTY,** a character in George Eliot's *Adam Bede* (1859), who kills her newborn, illegitimate child. Her death-sentence is commuted to transportation. G. G. F.

**SORREL,** also sheep sorrel or sour dock, a small herb, *Rumex acetosella,* of the buckwheat family naturalized in North America from Europe and Asia. It is a perennial with running rootstocks, and acid-tasting, halberd-shaped leaves. The tiny flowers, clustered on branching stalks, are yellowish or reddish. Its vigorous creeping habit makes it a troublesome weed in lawns and gardens. J. C. Wis.

**SORREL TREE,** a medium-sized tree, *Oxydendrum arboreum,* of the heath family, also called sour-wood. It is found from Pennsylvania and Indiana to Florida and Louisiana. The sorrel tree has a central trunk and slender branches, and sprays of small urn-shaped white flowers in clusters in summer. It is planted for the brilliant fall color of the sour, oblong leaves. J. C. Wis.

**SORRENTO** [sorrɛ′nto], a resort town on the southern shore of the Bay of Naples, located in Napoli Province, southern Italy, about 25 mi. west of Salerno. The town, strung out on terraces rising to 200 ft. above the sea, lies on the coast road between Naples and Amalfi, and is served by rail, steamer, and busses. Its picturesque site and mild climate have made Sorrento popular with sojourners. The remains of the Roman and medieval eras are fragmentary and of no great interest. Sorrento early became an episcopal seat, and during the Dark Ages appears to have been largely independent under its own dukes, and often in conflict with Amalfi and the Saracens. In 1137, it fell to the Normans and thereafter shared the political fortunes of Naples and its kingdom. Pop. (est.), 9,898. R. G. W.

**SORROWS OF YOUNG WERTHER, THE,** a sentimental and psychological novel in letter form, written by Johann Wolfgang von Goethe and published in 1774, with the title *Die Leiden des jungen Werthers.* The work established its author's international fame. It contains in its first part a more or less biographical account of Goethe's unhappy infatuation for Charlotte ("Lotte") Buff, fiancée of his friend G. C. Kestner, during the poet's otherwise happy summer of 1772 at Wetzlar, where he served his jurisdictional apprenticeship at the supreme court of the Holy Roman Empire. Its second part is based on the unfortunate experiences and fate of Karl Wilhelm Jerusalem, secretary of the Brunswick ambassador, who, snubbed by the aristocratic society of the Court, reprimanded by his superiors, and in love with the wife of a colleague, committed suicide in October 1772. The fusion and crystallization of these materials and characters, however, was effected through a painful incident that Goethe experienced in February 1774 at the house of the jealous husband of Maximiliane Brentano.

The sensational success of the novel cannot be attributed exclusively to the consummate art with which Goethe tells an apparently simple love story in epistolary form. Since the publication of the *Letters of a Portuguese Nun* (1669), the epistolary novel had slowly matured in such works as the writings of Samuel Richardson and in Jean Jacques Rousseau's *Julie; ou, la Nouvelle Héloise,* and *Werther* is one of the finest examples of the form. The letters of Werther are ostensibly written to a friend, whose sympathetic and warning voice might well be the reader's. But the content of the novel is more than the fate of Werther, who assumes that the outside world corresponds to the picture of it that he bears in his own heart. It is the creed of a whole generation protesting against the facile and optimistic rationalism of their elders who had viewed the marvelous abundance of nature as a system of abstract laws, its mysterious creator as a clockmaker, its life adventures as a set of moral precepts, and its devious paths of frustration and attainment as a calculable road to happiness to be reached through reasonable behavior. *Werther* proclaimed, in opposition to this view, the rights of the heart. The enthusiastic response of its readers, the translations of the novel into most European languages, its sequels, imitations, and dramatizations, and the *Wertherfieber* which was its unfortunate aftermath testify to Goethe's success in directing into a single channel the manifold currents of sentimentalism. E. F.

**SORSOGON** [sɔ′rsogɔ′n], a Philippine municipality and port, the capital of Sorsogon Province, located on Sorsogon Bay near the southeast tip of Luzon. At the mouth of the Sampaloc River, which flows into the head of the bay, the town lies on level ground but is surrounded by rolling, fertile terrain of volcanic origin. The shore line in front of the town rises abruptly, and fishing houses have been built over the bay. Abaca is the chief product, but copra is also exported and fish are sold to other parts of the Philippines. Sweet potatoes and cassava are major food crops in the province. The 16-mile-long bay affords excellent protection, but near its head the water is shallow, making it necessary for most vessels to anchor two or three miles from the port and transfer their cargo into smaller craft. In 1840 a severe earthquake killed seventeen persons, injured many more, destroyed many buildings, and caused the land to drop from four to five feet below its former level. Pop. 1948 (town) 9,971; (municipality) 26,004. A. Cu.

**SOSNOWIEC** [sɔsnɔ′vyɛts], a city in the Polish province of Kielce, located 35 mi. northwest of Kraków and about 160 mi. southwest of Warsaw in the Silesian coal area. It is an important railway junction and before World War

II was the second largest industrial city of Poland and the center of Polish coal mining. The city's industries include textile factories, rolling mills, electric power stations, and steel works. Pop. 1946, 77,834. L. M. A.

**SOTHERN, EDWARD HUGH** [sʌ′thərn] (1859-1933), American actor, son of the Anglo-American actor Edward Askew Sothern, was born in New Orleans, La., on Dec. 6, 1859. He was married twice: to Virginia Harned in 1896,

EDWARD HUGH SOTHERN

BROWN BROTHERS

and to Julia Marlowe in 1911. He toured England in 1882 and 1883 and joined the company of John McCullough in the latter year; from then until 1899 he was leading man in Daniel Frohman's Lyceum Theatre company in New York. Sothern had enormous success in romantic comedies on the order of *Richard Lovelace, If I Were King,* and *The Prisoner of Zenda,* and in Gerhart Hauptmann's mystical play, *The Sunken Bell.* He first played Hamlet in 1900. In 1904 he made his first appearance opposite Julia Marlowe in *Romeo and Juliet.* Thereafter their notable partnership in Shakespearean repertory made them foremost exponents of the Classic drama of their day. In 1916 he presented a gala revival of *If I Were King* to raise money for the British Red Cross. After Miss Marlowe's permanent retirement from the theatre in 1924, Sothern appeared under the management of David Belasco in two plays, *Accused* and *Hidden,* in 1925 and 1926, after which he left the stage to embark on a lecture tour. He said at the time, "I have not left the stage; the stage has left me." Sothern's autobiography, *The Melancholy Tale of Me,* was published in 1916. He died Oct. 28, 1933, in New York City. E. C. Ro.

**SOTHO.** *See* African Peoples.

**SOTOL** [so′tol; soto′l], a common name for *Dasylirion,* a genus of treelike desert plants of the lily family. The plants, to 6 ft. in height, bear linear, usually spiny, marginal leaves, and whitish lilylike flowers in dense panicled racemes. The leaves are used for thatching or baskets, and the fiber is made into cordage; the heads are edible, and the sap is sometimes made into an alcoholic beverage. All species are native to Texas, Arizona, and Mexico. L. de F.

**SOUARI NUT** [suɑ′ri], also called suarrow, or sawarra, *Caryocar nuciferum,* a timber tree growing to 100 ft. in height, native to Surinam. It bears, within its huge woody fruit, a number of extremely hard-shelled, kidney-shaped, warty, nutlike seeds, 2 in. or more in length. In texture and flavor, the edible flesh resembles a Brazil nut but has a tinge of almond flavor. Though the flavor of this nut is one of the finest known, the trees do not occur in sufficient quantities to make shipment profitable. In their native land, the trees are used for ship timber. C. H. Wo.

**SOUEIDA** or **ES SUWEIDA** [swe′da′, æs sʊwai′də], a city in the southwestern part of Syria, located about 58 mi. southeast of Damascus and 60 mi. northeast of Jerusalem. It is a railroad terminus, built on the site of an ancient Roman town. Soueida is situated on the edge of the rugged plateau which includes the 5,900-ft. peak of Jebel Druze. The lava plateau has been eroded into sharp peaks and steep valleys and is an inaccessible, semidesert region. To the north of Soueida lies the flat, fertile, wheat-producing area, immediately southeast of former Druse territory of Jebel ed Druz. The climate of Soueida is a modified Mediterranean type with short, cool winters and long, hot, dry summers. The average annual precipitation is about 15 in. a year, and almost all the rain falls during the winter months. The vegetation is grass, thorn bushes, and some pine trees. Agriculture and grazing are the two most important activities, wheat, millet and some vegetables being the chief products, and goats, sheep, and camels the animals pastured. Soueida is a famous center of the Druses, survivors of a Mohammedan sect founded in the tenth century. This small but fierce group took refuge in remote and inaccessible areas, winning from the French a semi-independent state within the French Mandate, with Soueida as their principal city. The Druses fought all French attempts to control the region and assisted Damascus in its attempted revolts in 1920 and 1926. Soueida was incorporated in the Arabic Republic of Syria on Jan. 12, 1942. Pop. 1953, 12,153. J. E. F.

**SOULT, NICOLAS JEAN DE DIEU (DUC DE DALMATIE)** [su′lt] (1769-1851), French marshal, was born at Saint-Amans-la-Bastide in the south of France on Mar. 29, 1769. At the age of sixteen he entered the French army, becoming a second lieutenant in 1791 and a captain two years later. He participated in the war against the First Coalition, and was made a general in 1794, but he showed his great strategical skill particularly in the Swiss and Italian campaigns (1799 and 1800) under André Masséna. Nominated marshal the day after the proclamation of Napoleon I as Emperor (1804), Soult took a decisive part in the Battle of Austerlitz (1805) and in the war against Prussia and Russia (1806-1807). Made Duke of Dalmatia in 1807, he was sent to Spain at the end of that year, where he was the leading French general until the beginning of 1813. After having participated in the initial battles of the Wars of Liberation, in the summer he was again dispatched to the south of France in order to stem the onslaught of the Duke of Wellington. During the First Restoration, Soult was made minister of war, but during the Hundred Days he accepted the post of chief of staff to Napoleon. From 1816 to 1819 Soult was exiled from France, but was called back by the Crown, which renewed his marshalship the following year and his peerage in 1827. Just as his political convictions had not hindered Soult from serving the Republic as well as the Empire and the Bourbons, he accepted under Louis Philippe the post of war minister during 1834. He was minister for foreign affairs in 1839, head of the government during 1832-1834, 1839-1840, and again in 1840-1847, foreign minister in 1839-1840, and ambassador extraordinary for the coronation

of Queen Victoria in 1838. Soult died at his castle of Soultberg, near his birthplace, on Nov. 26, 1851. W. Fr.

**SOUND,** the vibrational motion of matter displaced from equilibrium. In a continuous material, the displacement of one particle from its rest position causes a displacement of neighboring particles by elastic forces, and the disturbance spreads through the material in the form of a sound wave.

Sound may produce the sensation of hearing when vibrations occur in air more frequently than 15 or 20 times a second and less frequently than about 20,000 times a second. The frequency of a vibration is measured in cycles per second (c.p.s.) and is given by the number of times per second a vibrating object moves through its equilibrium position in the same direction. Thus, a sound is audible when its frequency lies between about 15 and 20,000 c.p.s. Frequencies lower than 15 c.p.s. are called subsonic, and frequencies greater than 20,000 c.p.s. are called ultrasonic. The word supersonic was sometimes used to denote ultrasonic, but now applies to a speed greater than the speed of sound in air. Normal human ears cannot hear sounds with ultrasonic frequencies, although some people and certain animals, e.g., dogs and bats, can hear frequencies well above the average limit of human audibility. Sounds with subsonic frequencies cannot be heard but may be experienced as a sense of bodily vibration or as pressure. Many subsonic vibrations are accompanied by audible sounds, but the sensation of hearing can usually be distinguished quite readily from the kinesthetic sensation caused by low-frequency vibration.

Considered as a physical phenomenon, sound includes mechanical vibrations with a much wider range of frequencies than that determined by the limits of audibility. The subjects of seismology and structural mechanics are concerned with frequencies of about one cycle per second or less, whereas molecular vibrations, considered in quantum mechanics, have frequencies of the order of 1 billion cycles per second or more. Acoustics, the science of sound, deals with vibrational motion in the intermediate frequency range between 1 c.p.s. and $10^9$ c.p.s.

The distinction between sound and vibration is largely a matter of viewpoint, since both words describe the same physical phenomenon. When attention is fixed on an individual object or particle, a repeated to-and-fro motion is called periodic motion or vibration. When the periodic motion of an individual particle is due to pressure exerted by neighboring particles of the same material or a surrounding medium, the related motions of the entire group of particles are called sound. These form a wave which progresses through the material with a definite speed in approximately the same way that a wave of disturbance travels through a closely spaced row of dominoes standing on end when one is tipped over.

## SIMPLE VIBRATING SYSTEMS

**Free Vibrations of a Mass and a Spring.** The simplest vibrating system contains two components, a mass and a spring, each associated with a characteristic type of force. The force required to extend or compress a spring unit distance is called the stiffness, $k$, of the spring. If one end of a spring is fixed, a displacement, $x$, of the other end from its equilibrium position is accomplished by a force, $F_k$, given by Hooke's law: $F_k = -kx$.

The negative sign indicates that the force exerted by the spring opposes the displacement. This restoring force acts to return the displaced end of the spring to its equilibrium position whether the spring is compressed or extended. If the displacement is too large, the spring can be permanently distorted, and Hooke's law will not apply. But in most systems related to sound, the vibrations are small and the restoring force is proportional to the displacement. When this is true, a spring possesses a linear, or Hooke's law, stiffness.

*Simple Harmonic Motion.* A fundamental type of vibration known as simple harmonic motion occurs when the force of a spring acts directly on a mass. The force between the spring and the mass obeys both Hooke's law and Newton's law, so that the equation of motion is $F = ma = -kx$; and the acceleration, $a = -\frac{k}{m}x$, is proportional to the displacement but in the opposite direction.

An important feature of the free vibrations of linear spring-mass systems is that the natural frequency does not depend on the amplitude but only on the ratio of stiffness to mass.

*Damped Systems.* The vibrational motion of a spring-mass system has been identified as simple harmonic motion, in which the amplitude does not change with time. It is common observation, however, that free vibrations gradually die away. This behavior, called decay, is due to the presence of a third component, resistance, in the system. A resistance is characterized by a force which opposes the motion and is (to a first approximation) proportional to the velocity; a system which contains such forces is called a damped or dissipative system.

Sound and vibration involve two principal types of resistance, namely, friction and radiation. Frictional resistance

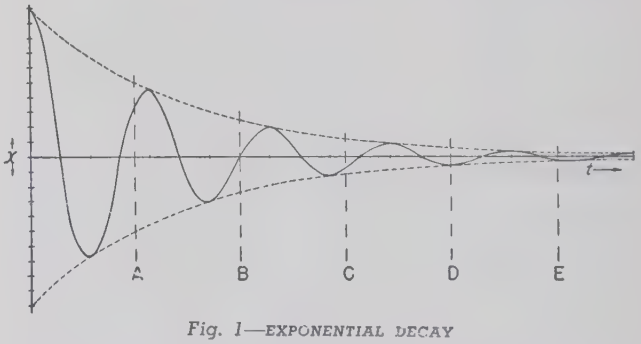



*Fig. 1—EXPONENTIAL DECAY*

*Reduction in amplitude of vibration as compared with original value of amplitude: (A) ½; (B) ¼; (C) ⅛; (D) 1/16; and (E) 1/32 (x) Displacement; (t) Time*

accompanies the flow of a viscous liquid or gas around an obstacle. Radiation resistance occurs when a vibrating object produces sound waves which carry energy away. Both types of resistance exert a force, $F_r$, on a moving object described by: $F_r = -rv$, where $r$ is a constant called the *resistance.*

When resistance is added to a spring-mass system, the equation of motion must be modified to read:

$$a = -\frac{k}{m}x - \frac{r}{m}v.$$

It is characteristic of the free vibrations of a damped system that the displacement amplitude decreases by the same fraction during all equal intervals of time. This behavior, known as exponential decay, is illustrated in Fig. 1. The damping of an exponential decay is described by a decay constant, $k = r/2m$, or by the reciprocal ratio, $2m/r$, which is called the modulus of decay and is the time interval required for the amplitude to decrease to $1/e (= 0.368\ldots)$ of its value at the beginning of the interval. The addition of resistance to a spring-mass system causes a small reduction

in the natural frequency, but for the resistances encountered in acoustics this effect is so small that it is usually ignored.

**Forced Vibrations of a Damped System.** *Sinusoidal Force.* Under the influence of an applied periodic force, a damped simple system undergoes forced vibration. The simplest type of an external periodic force is one that varies sinusoidally with time: $F=F_0 \cos \omega t$, where $F_0$ is the force amplitude and $\omega$ is the driving (angular) frequency. Since $\omega$ is a property of the external driving force, it may take on any value whatever, as distinguished from the natural frequency, $\omega_n=2\pi\nu_n$, which has a particular value determined by the constants of the system. The special case in which the driving frequency has the same value as the natural frequency is called resonance.

When a sinusoidal driving force is first applied to a system at rest, the initial motion, called the transient, is very complicated. But if the driving force continues with a steady frequency and amplitude, the vibration settles down to a steady state simple harmonic motion that continues as long as the driving force continues unchanged. The frequency of the steady-state vibration of a linear system is always the same as the frequency of the applied force, but the amplitude of the forced motion depends on the frequency.

*Impedance.* The responsiveness of a system in forced vibrational motion is described by the impedance of the system. A system with high impedance is hard to move and requires a large force amplitude to produce a specified amplitude of vibration, whereas a system with low impedance moves easily. The impedance, $z$, is defined as the force divided by the velocity, and its magnitude is the force amplitude required to produce a velocity amplitude of one centimeter per second. The impedance of a system generally varies with frequency.

When a force, $F$, is applied to an element of pure resistance, the resulting velocity is determined by a balance between the applied force and the resistive force, $F+F_r=0$. Since the resistive force is $F_r=-rv$, the ratio of applied force to velocity is: $z_r=F/v=r$; therefore, the impedance of a resistive element is independent of frequency and is equal to the resistance.

In a spring, an applied force, $F$, causes a displacement rather than a velocity: $F=kx$. But in simple harmonic motion the velocity is 90 deg. ahead of the displacement in phase and the velocity amplitude is larger than the displacement amplitude by a factor of $\omega$. This statement can be written: $x=v/\omega/\underline{-90^\circ}$; so that the impedance of a stiffness is $z_k=F/v=k/\omega/\underline{-90^\circ}$. It is clear that impedance is a vector quantity, since both its magnitude and phase angle must be specified. In this case the angle $/\underline{-90^\circ}$ indicates that the force, which has the same phase as the displacement, is 90 deg. behind the velocity in phase.

In a mass, an applied force causes an acceleration, $a=F/m$. In simple harmonic motion, the acceleration is 90 deg. ahead of the velocity in phase and the acceleration amplitude is $\omega$ times the velocity amplitude, so that: $a=\omega v/\underline{+90^\circ}$; therefore the impedance of a mass is: $z_m=F/v=\omega m/\underline{+90^\circ}$.

When a spring, a mass, and a resistance are combined into a simple system, the impedances of the three elements also combine; but because of the various phase angles, the impedances combine as vectors. At any frequency, the vector sum of the components of impedance gives the amplitude of the force required to produce unit velocity amplitude and the phase difference between the applied force and the velocity. Resonance occurs when the impedance of the spring just balances the impedance of the mass: $\omega m=k/\omega$, or $\omega=\sqrt{k/m}=\omega_n$.

At low frequencies, the impedance of the spring, $k/\omega$, is much larger than that of the mass or the resistance; at these frequencies, the motion is stiffness-controlled and the applied force is very nearly in phase with the displacement. Near resonance, the impedances of the mass and the stiffness are nearly equal, but they have opposite phase angles and hence cancel each other. The major contribution to the vector sum comes from the impedance of the resistance; such motion is resistance-controlled, and the force is approximately in phase with the velocity. At high frequencies, the major contribution to the total impedance comes from the mass impedance, $\omega m$, so the motion is mass-controlled and the force is very nearly in phase with the acceleration.

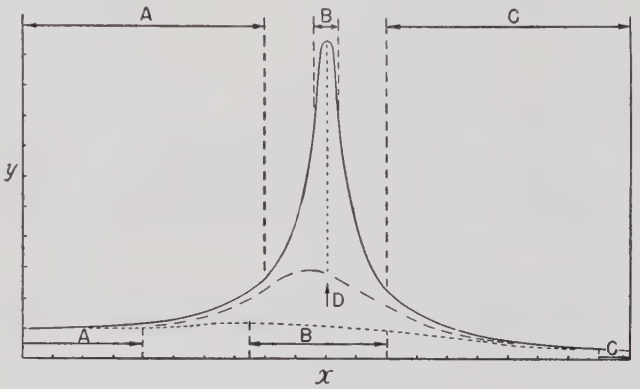



*Fig. 2—DISPLACEMENT AMPLITUDE OF A FORCED VIBRATION AT VARIOUS FREQUENCIES*

*(A) Stiffness-controlled; (B) Resistance-controlled; (C) Mass-controlled; (D) Resonance*
*(x) Displacement; (y) Frequency of applied force*

Because of the large impedance of a stiffness-controlled or a mass-controlled system, the displacement amplitude is low at frequencies well above or below the resonant frequency. In the vibrating systems of interest in acoustics, the resistance is usually much smaller than the impedances of the mass or the stiffness. Consequently, there is a low impedance in the resistance-controlled region, and the displacement amplitude passes through a maximum at resonance. The value of the displacement amplitude at various frequencies is shown in Fig. 2 for a simple system driven with a constant force amplitude. In this figure, the solid curve shows the behavior of a system with a small resistance, and the dotted curves show the behavior of systems with larger resistances.

*Complex Wave Forms.* Thus far, the discussion of forced motion has been limited to the case of a driving force which varies sinusoidally with time. It frequently happens, however, that the wave shape of the applied periodic force is not sinusoidal. Such cases are treated by considering the complex shape of the curve of force versus time as the sum of a number of sinusoidal forces with various frequencies and amplitudes acting simultaneously.

After a complex wave form has been analyzed into sinusoidal components by the techniques of Fourier analysis, the displacement due to each sinusoidal component can be obtained by evaluating the impedance at the appropriate frequency. The wave shape of the total displacement is then the sum of the component displacements at each of the frequencies in the harmonic series. These methods of analysis

and synthesis of complex wave forms are of great importance in the study of vibration and sound.

**Coupled Systems.** The previous sections considered the free and forced vibration of the simplest mechanical system, containing only a simple element of mass, of stiffness, and of resistance. This simple system can frequently be used to represent the gross behavior of a practical vibrating system such as a loudspeaker; the mass of the coil is acted on by the stiffness of the diaphragm and the motion is damped by the resistance of the sound radiated. Closer examination of the actual vibrating system, however, usually shows that more than one mass and more than one spring are involved. In a loudspeaker (*see* Fig. 3), each of the corrugated rings in the diaphragm acts as an element of stiffness, and the areas between the rings contribute mass and resistance.

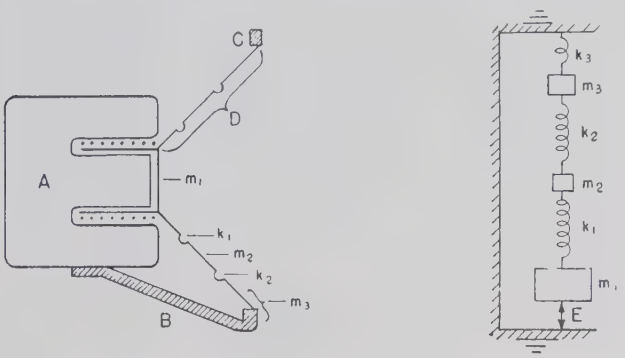



*Fig. 3—DYNAMIC LOUDSPEAKER (LEFT), AND EQUIVALENT COUPLED SYSTEM (RIGHT); (RADIATION RESISTANCE NEGLECTED)*

*(A) Magnet, large mass; (B) Bracket supporting the ring, stiffness $k_3$; (C) Ring; (D) Corrugated paper diaphragm; (E) Driving force applied between coil, $m_1$, and the large mass of the magnet, A; ($m_1$) Coil; ($m_2$ and $m_3$) Masses; ($k_1$ and $k_2$) Stiffness*

A single system that involves two or more masses interconnected by springs is called a coupled system. A characteristic of coupled systems is that the displacement of any single mass from its equilibrium position causes forces to act on the other masses of the system, as can be seen in the simple coupled system shown in Fig. 4. When either mass is displaced, the coupling stiffness, $k_c$, exerts a force on the other mass.

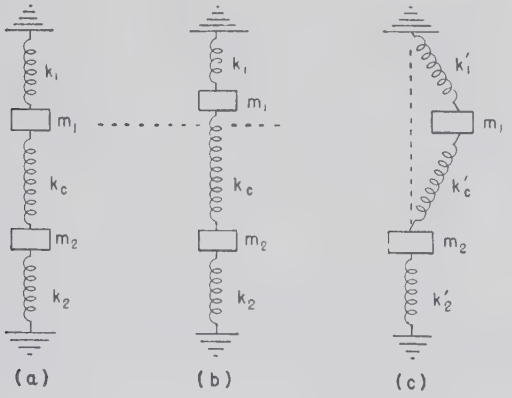



*Fig. 4—SIMPLE COUPLED SYSTEM*

*(a) System in equilibrium*
*(b) Upper mass displaced upward (longitudinally); force must be exerted on lower mass to keep it in equilibrium position*
*(c) Upper mass displaced sideward (transversely); force must be exerted on lower mass to keep it in equilibrium position. (The prime marks indicate that different values of the stiffnesses apply to tranverse displacements.)*

The behavior of a coupled system is most easily described in terms of the properties of the component simple systems. In Fig. 4, when the mass $m_2$ is clamped so that it cannot move, $m_1$ behaves like a simple system with a natural frequency at: $\omega_1 = \sqrt{\frac{k_1 + k_c}{m_1}}$. Likewise, when $m_2$ is clamped, $m_1$ behaves as a simple system with a natural frequency: $\omega_2 = \sqrt{\frac{k_2 + k_c}{m_2}}$.

When both masses are free to move, the system has two resonant frequencies instead of one. However, the coupling between the two simple systems causes the two resonant frequencies to lie farther apart than the two clamped frequencies. Even when the natural frequencies of the clamped simple systems have the same value, the two resonances of the coupled system are separated; one lies above and one below the common natural frequency.

The amounts by which the resonant frequencies are shifted depend on the degree of coupling. For very weak coupling, the resonances are shifted only a small amount. For a very strong coupling, one resonance of the coupled system occurs at a very high frequency, whereas the other resonance approaches the value obtained by combining the two masses into a single rigid body. The displacement amplitudes of the masses of a driven coupled system are shown in Figs. 5*a* and 5*b*, as a function of the frequency of the applied force.

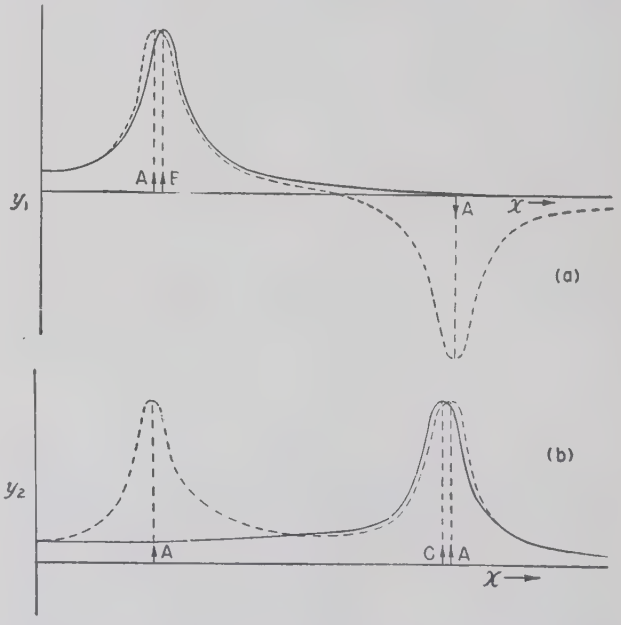



*Fig. 5—Displacement amplitudes of two masses in a coupled system; solid curves show displacement of one mass when other mass is clamped, while broken curves show displacement when both masses are free. (A) Resonance of coupled system; (B) Clamped natural frequency of $m_1$; (C) Clamped natural frequency of $m_2$. (x) Driving frequency; ($y_1$) Displacement amplitude of $m_1$; ($y_2$) Displacement amplitude of $m_2$.*

*Normal Modes of Vibration.* The character of the displacements is not the same at the two resonances. In the neighborhood of the low-frequency resonance, the two masses have the same phase, whereas in the neighborhood of the high-frequency resonance, the masses are always on

opposite sides of their equilibrium position and hence differ by 180 deg. in phase. The ratio of the amplitude of $m_1$ to the amplitude of $m_2$ depends in a complicated way on the values of the masses and stiffnesses involved. The types of displacement patterns for two equal masses in a coupled system are illustrated in Fig. 6. These same two patterns

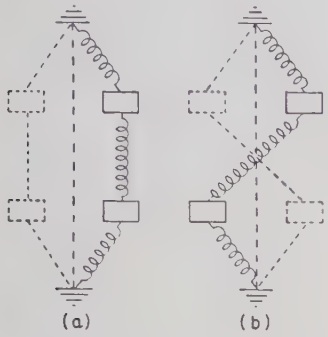



*Fig. 6—Normal modes of vibration of two equal masses: (a) Low-frequency resonance; (b) High-frequency resonance.*

of displacement are also associated with the free vibrations of the coupled system. If the masses are displaced initially into the pattern shown in Fig. 6b, both masses vibrate freely with simple harmonic motion at the lower resonant frequency. If the initial displacements follow the pattern of Fig. 6b, both masses vibrate with simple harmonic motion at the higher frequency. The patterns of the relative positions of the masses at the resonant frequencies are called the normal modes of vibration of the system, and in general each normal mode has a different natural frequency. The number of normal modes of a complex system is equal to the number of simple oscillators coupled together.

*Arbitrary Displacement.* If the initial conditions of a freely vibrating coupled system correspond to one of the normal modes, all masses move with simple harmonic motion at the natural frequency of that normal mode. If, however, the initial conditions do not correspond to one of the normal modes, the masses carry out a complicated motion that is not generally periodic and hence cannot be said to have a frequency. This motion consists of a combination of several simple harmonic motions with different frequencies and different amplitudes. By adding together the displacement patterns of all the normal modes of a system, each with an appropriate amplitude, it is possible to obtain any arbitrary initial displacement pattern. The analysis of an arbitrary displacement pattern into normal mode components is illustrated in Fig. 7. The possibility of constructing an arbitrary displacement pattern by adding together the patterns of the normal modes is a fundamental property of the normal modes of a system. Thus, the complicated motion of a free system can be described by finding the relative contribution of each normal mode to the initial displacement pattern, and by considering that the system vibrates with independent simple harmonic motions simultaneously at the natural frequency of each normal mode.

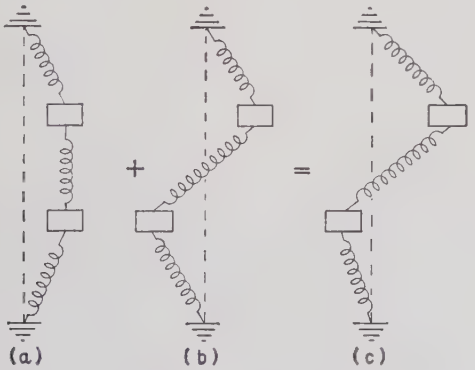



*Fig. 7—Analysis of arbitrary displacement pattern: (a) One normal-mode component; (b) A second normal-mode component; (c) Arbitrary displacement pattern, being the sum of a and b.*

When appreciable resistance is present in a coupled system, the free motion of the masses in the normal modes of vibration consists of damped harmonic vibrations rather than simple harmonic vibrations. In general, each normal mode has a different damping constant.

## DISTRIBUTED SYSTEMS AND WAVE MOTION

**Waves on a String.** The previous section described the vibrational motion of lumped systems containing individual elements of mass, stiffness, and resistance. In contrast, a stretched flexible string is a distributed system; a continuous material in which it is no longer possible to distinguish between masslike and springlike elements. The stretched string, a one-dimensional system, serves to illustrate several basic properties of wave motion without the complications encountered in systems distributed in two or three dimensions.

In describing the motion of a coupled system, as in the preceding section, it is necessary to specify the position of each mass as a function of time. Now, suppose that the number of coupled masses becomes very large and that the weight of each mass and the separation between masses becomes very small. If this process is carried far enough, the discrete coupled masses can no longer be distinguished, and the system becomes essentially a continuous elastic string with a "uniform" density. To describe the motion of this distributed system it is necessary to specify the displacement of every point along the string as a function of time, i.e., to give an equation for the displacement as a function of position as well as time.

At a given instant of time, the displacement and the phase vary from point to point along the string; with the passage of time, however, the pattern of the displacement moves along the string at a constant velocity and without change in shape. The progression of a displacement pattern constitutes a wave motion, and the ability to propagate waves of arbitrary shape is a fundamental property of distributed systems. Waves on a string and in air are propagated without change in shape, but some types of wave motion, particularly surface waves, involve a progressive change in the shape of the waves.

*Traveling Wave.* The simplest type of wave is a sinusoidal traveling wave, which can be produced in a long stretched string by moving one point with simple harmonic motion. If the driving point is moved back and forth parallel to the length of the string, the waves are longitudinal, and if the driving point is moved at right angles to the length of the string, the waves are transverse. In either case, other points in the string move with simple harmonic motion of the same frequency and amplitude as the driving point but with different values of the phase. A transverse wave travels with a velocity, $c$, given by $c = \sqrt{T/\mu}$, where $T$ is the tension in the string and $\mu$ is the mass per unit length. Thus, if the phase at the driving point is $\omega t$, the phase at a distance $x$ from the origin is $\omega(t-x/c)$, since $x/c$ is the time required for a disturbance moving with velocity $c$ to travel a distance $x$. Because of this uniform change in phase with distance, the displacement at a given instant in time varies

sinusoidally with distance; and with the passage of time, the sinusoidal pattern of displacement moves away from the driving point with a constant velocity, as shown in Fig. 8.

The distance between two points which have maximum displacement at the same time is called the wave length λ.

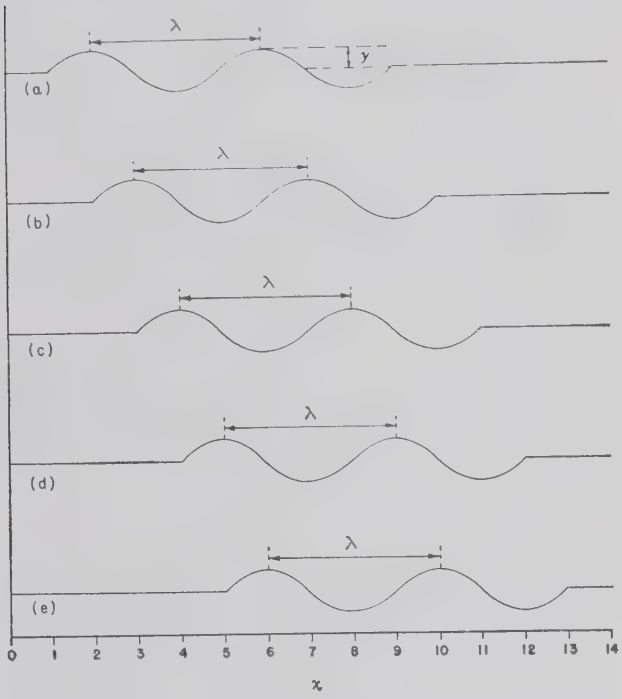



*Fig. 8—Motion of a wave train, consisting of two cycles, along a string; the time interval between the successive drawings (a,b,c, etc.) is one-fourth period, and the elapsed time between a and e is one period, T. (x) Distance; (y) Amplitude.*

The time between the arrival of successive maxima at the same point is the period, $T=1/\nu$. So, if a point of maximum displacement, or any other point in the wave pattern, travels a distance λ in a time $T=1/\nu$, the velocity must be: $c=\lambda/T=\lambda\nu$.

This fundamental relation for all sinusoidal traveling waves states that the distance a wave travels in one second is equal to the distance between successive points of equal phase times the number of such points arriving in one second. It can be seen that high-frequency waves have short wave lengths and that low-frequency waves have long wave lengths.

The force required to generate a transverse wave of a given amplitude varies with the tension and with the mass per unit length of the string. It is measured by the ratio of force to velocity, i.e., the impedance, of the driving point, which has the value: $z_o=\mu c=\sqrt{\mu T}$ (zero phase angle) for each direction of wave propagation. When the string extends in both directions away from the driving point, the impedance is $2z_o$, but when the driving point is at one end of the string, waves are propagated only in one direction and the impedance is $z_o$. In other words, a wave train in a very long string has a resistance which is constant for all frequencies in the same way as a lumped resistance element. The value, $z_o$, of the impedance of a driving point in a very long string is known as the characteristic impedance of the string.

It is implicit in the idea of a traveling or progressive wave that the ends of the string are sufficiently distant to have no influence on the waves being considered. In general, however, an end has the effect of reflecting a traveling wave. The ends of a stretched string are usually connected to a lumped mechanical system such as a large mass, a stiff spring, or some combination of such elements. When the impedance of the termination is very large compared with the characteristic impedance of the string, the end of the string does not move appreciably, and the reflected wave has the same amplitude as the incident wave but differs by 180 deg. in phase. At an end that moves freely, the reflected wave has the same phase as the transmitted wave.

*Standing Wave.* When two waves traveling in opposite directions encounter each other, the resulting displacement of the string is simply the sum of the displacements which would occur independently in each wave. After the wave trains have passed each other, they are entirely unaffected by the encounter. Each wave maintains its identity independent of the other, but in regions where two waves are present at the same time, the waves are superposed. The superposition of sinusoidal waves having the same frequency and amplitude but traveling in opposite directions results in a type of motion known as a standing wave, as illustrated in Fig. 9. Certain points, called nodes, have zero amplitude, since the displacements of the two waves are always 180 deg. out of phase at these points and therefore cancel each other. Midway between two nodes, the displacements of the two traveling waves are alternately in phase and out of phase; here the displacement amplitude of the string is twice the amplitude of either wave independently. Such points are called antinodes or loops. The distance between adjacent nodes is half a wave length, and the distance between a node and an antinode is a quarter of a wave length. When the end of a string is connected to a rigid (high-impedance) structure, a node occurs at the end, but when the string has a low-impedance termination, e.g., a long light spring, an antinode occurs at the end. In either case, nodes and anti-

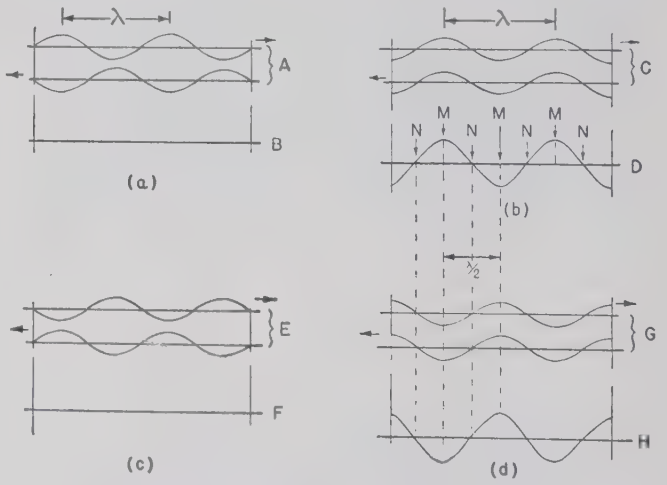



*Fig. 9—ADDITION OF TWO TRAVELING WAVES; OF EQUAL FREQUENCY AND EQUAL AMPLITUDE, TO FORM A STANDING WAVE*

*(a) Waves cancel each other completely, and their sum is zero*
*(b) Waves having progressed in opposite directions by a quarter wave length; they are in phase and add to give positive and negative displacements of twice the value in each wave*
*(c) Waves having progressed in opposite directions by a half wave length; they are opposite in phase and cancel each other*
*(d) Further travel of an additional quarter wave length results in a relationship that is similar to that in b but out of phase with the latter by 180°*
*(A,C,E,G) Traveling waves; (B,D,F,H) Sum; (M) Anti-node; (N) Node*

nodes occur successively every quarter wave length along the string.

*Natural Frequencies.* Consider, now, the effect of a second boundary point. Suppose that a string is stretched tightly between two immovable points a fixed distance apart. A traveling wave on the string is reflected first at one end and then at the other, so that each boundary point produces a standing wave pattern with a nodal point at the end. However, nodal points always occur at intervals of half a wave length. In order to satisfy both of these conditions, it is necessary that the distance between the fixed points be an integral number of half wave lengths. Thus, a string which is fixed at both ends cannot carry out free vibrations except at those frequencies for which the length of the string is an integral multiple of the half wave length. These frequencies are called the natural frequencies of free vibration, and associated with each natural frequency there is a characteristic standing-wave pattern that constitutes one of the normal modes of vibration of the string. The fundamental frequency occurs when there is only one loop between the nodes at each end, the length of the string is $L = \lambda/2$, and the frequency is $\nu_1 = c/2L = \sqrt{T}/2L\sqrt{\mu}$. As an example, the D string on a violin has a vibrating length of 33 cm. and a mass per unit length of 0.0115 gram per centimeter. When the tension on this string is $4.32 \times 10^6$ dynes per centimeter, the fundamental frequency is:

$$\frac{1}{2 \times 33}\sqrt{\frac{4.32 \times 10^6}{0.0115}} = 294 \text{ c.p.s., the frequency of D.}$$

The second harmonic frequency is twice the fundamental and the corresponding normal mode has two antinodes and one node between the nodes at the ends. Higher natural frequencies occur at each multiple of the fundamental frequency, forming an harmonic series. The normal modes of vibration corresponding to the first four natural frequencies are shown in Fig. 10.

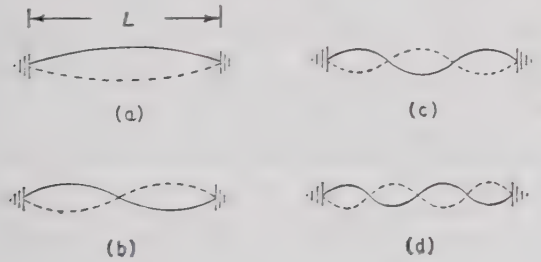



*Fig. 10—Normal modes of vibration associated with the first four natural frequencies of a string of length L fixed at both ends: (a) Fundamental ($\nu = \sqrt{T}/2L\sqrt{m}$); (b) Second harmonic ($\nu_2 = 2\ U_1$); (c) Third harmonic ($\nu_3 = 3U_1$); (d) Fourth harmonic ($\nu_4 = 4U_1$).*

As in the case of the free vibrations of a coupled system, the free vibration of a string released from an arbitrary initial displacement is very complicated. It can be described, however, by analyzing the initial shape of the string into components which follow the patterns of the various normal modes, in a manner similar to the Fourier analysis of complex wave forms. Each normal mode component then vibrates in its own characteristic standing-wave pattern at its own natural frequency. At a given instant, the displacement of any point on the string is the sum of the component displacements in the standing-wave motion of each of the normal modes.

*Bounded System.* A string rigidly terminated at one end and driven at the other end by a sinusoidal force of constant amplitude provides an example of the forced motion of a bounded system. There is no limitation on the frequencies of the waves that can be propagated on the string; every point on the string moves with simple harmonic motion at the frequency of the driving force. The presence of one rigid boundary causes a standing wave system with a node at the fixed end of the string; other nodes occur at intervals of half a wave length along the string. As the driving frequency is varied, the wave length changes and the nodal points move along the string in order to maintain a separation of half a wave length. Thus, depending on the wave length and the length of the string, the driving point may be at a node, at an antinode, or at any intermediate position. When the driving point is near a node, the amplitude at that point is small; the nodes are points of high impedance. The antinodes, however, are points of low impedance, since here the applied force causes a relatively large displacement at the driving point. As the frequency changes, the impedance at the driving point varies in a periodic manner. The frequencies of minimum driving point impedance are resonant frequencies, and the shape of the string at each of these frequencies is the same as the corresponding normal mode of vibration of a string fixed at one end and free at the other.

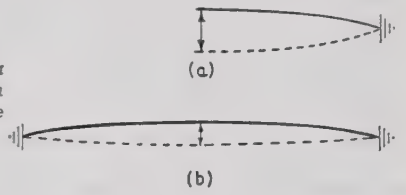



*Fig. 11—The case of a string fixed at both ends and driven in the middle*

The case of a string fixed at both ends and driven in the middle *b* is equivalent to the sum of two strings fixed at one end and driven at the other *a*. The driving-point impedances of the two component strings add, so the impedance of a string fixed at both ends and driven in the middle is twice that of a string half the length driven at one end, as illustrated in Fig. 11. The resonant frequencies of a string fixed at both ends occur at those frequencies for which the wave length is twice the distance between the two fixed ends.

**Wave Motion in Gases, Liquids, and Solids.** *Longitudinal Waves.* The wave motion of three-dimensional systems is necessarily more complex than the wave motion of a one-dimensional string, but there are many close analogies between waves on a string and waves in air, water, or solid bodies. In the discussion of strings, attention is focused chiefly on the propagation of transverse waves, since the transverse motion of a string is more readily observed than the longitudinal motion. However, the wave effects described also occur for longitudinal displacements. A longitudinal wave is associated with compression and expansion of the material while a transverse wave is associated with bending. A solid material, such as steel or rubber, can propagate either transverse or longitudinal waves. The two types of waves are transmitted with different velocities, since the compressive stiffness of a solid is different from the stiffness under bending. But in a fluid such as water or air, only longitudinal waves can be propagated, since it is not possible to "bend" a gas or a liquid.

In a longitudinal wave, the displacement of the particles from their equilibrium positions causes local regions of high pressure and low pressure. The difference between the instantaneous value of the total pressure at a point and the average value of the static pressure is called the sound pressure or the excess pressure; but since the static pressure is of relatively little concern in acoustics, the word "pressure,"

without the qualifying adjective, usually refers to sound pressure. The sound pressure takes on both positive and negative values and, over any extended period of time its linear average is zero. In an unconfined medium, the value of the excess pressure is proportional to the gradient (the spatial rate of change) of the displacement, so the regions of maximum and minimum pressure occur where the displacement is changing most rapidly. In a single-frequency compressional wave, the sound pressure and the displacement both vary sinusoidally with distance at a given instant of time, but the pressure leads the displacement by 90 deg. in phase.

*Intensity.* In order to produce sound pressure, it is necessary to disturb a condition of stable equilibrium in the medium. Consequently a sound source must supply energy to the medium in order to generate a sound wave. As the disturbed regions move away from the source in the form of a sound wave, they carry energy with them, so that there is a continuous flow of energy from the source into the medium. The amount of energy passing through a surface of unit area in one second is called the intensity of the sound wave. In a traveling wave which is several wave lengths away from its source, the intensity is proportional to the square of the sound pressure. At a given point in space, the intensity has not only a magnitude, but also a direction, so that it is a vector quantity. Since the intensity is the rate of energy flow, it represents power; it is usually measured in watts per square centimeter.

The magnitudes of the quantities involved in an audible sound wave are very small. For example, the minimum audible sound at 1,000 c.p.s. has the following characteristics:

| | | |
|---|---|---|
| Pressure amplitude | $=2\times10^{-4}$dynes/cm.$^2$ | or $3\times10^{-9}$lb./in.$^2$ |
| Displacement amplitude | $=8\times10^{-10}$cm. | or $3\times10^{-10}$in. |
| Velocity amplitude | $=5\times10^{-6}$cm./sec. | or $2\times10^{-6}$in./sec. |
| Intensity | $=10^{-16}$watts/cm.$^2$ | |

The intensity of a sound wave is sometimes expressed as a logarithmic ratio by the relation $N = 10 \log_{10} (I/I_0)$, where $N$ is the number of decibels (db.), $I$ is the intensity, and $I_0$ is the reference intensity ($I_0 = 10^{-16}$ watts/cm.$^2$). On the decibel scale, the minimum audible sound at 1,000 c.p.s. is approximately 0 db., and a 1,000-c.p.s. sound becomes painful at an intensity level of about 120 db.

A painfully loud sound at 1,000 c.p.s. has the following characteristics:

| | | |
|---|---|---|
| Pressure amplitude | $=2\times10^2$dynes/cm.$^2$ | or 0.003 lb./in.$^2$ |
| Displacement amplitude | $=0.0008$ cm. | or 0.0003 in. |
| Velocity amplitude | $=5$ cm./sec. | or 2 in./sec. |
| Intensity | $=10^{-4}$watts/cm.$^2$ | |

*Velocity.* For small changes in pressure, the compressional stiffness of the air is quite accurately proportional to the static pressure, and the general relation for the velocity of a wave, i.e., $\sqrt{\text{stiffness/mass}}$, in air is: $c=\sqrt{P_0\gamma/\rho}$, where $c$ is the wave velocity, $P_0$ is the static pressure (about $10^6$ dynes per square centimeter at one atmosphere), $\rho$ is the density (0.0012 gram per cubic centimeter for normal air) and $\gamma$ is a constant with a numerical value of 1.4 for normal air ($\gamma$ is the ratio of the specific heat of air at constant pressure to the specific heat at constant volume). The quantity $P_0\gamma$ is the stiffness of a unit volume of air and $\rho$ is the mass of a unit volume. The velocity of sound also varies with temperature since the density and pressure of air both change with temperature. At a pressure of one atmosphere and at 32° F., the velocity of sound in air is 1,088 ft. per second (332 meters per second), or about 740 m.p.h. The velocity increases about one foot per second for each degree Fahrenheit of increase in temperature.

When air particles are permitted to move only in one dimension, as in a long straight tube, there is a complete analogy between the wave motion of the air and the wave motion of a string. A one-dimensional wave motion in a three-dimensional medium is known as a plane wave, since the behavior of the medium is uniform over any plane perpendicular to the direction of wave propagation. In a three-dimensional medium, it is necessary to make a modification in the concept of impedance, since a driving force cannot be applied to a point but must be distributed over an area. Hence the three-dimensional impedance is defined as the ratio of pressure (force per unit area) to velocity, instead of force to velocity. The ratio of pressure to velocity is called unit-area impedance as distinguished from the ratio of force to velocity, which is called mechanical impedance. The impedance of a very long column of air of unit area to plane wave motion is the characteristic impedance of air; it is commonly designated by the expression $\rho c$ (pronounced "rho-see"), since it is the product of the density, $\rho$, and the velocity of sound, $c$. The $\rho c$ of air is a pure resistance, and for normal air its numerical value is such that a pressure amplitude of 42 dynes per square centimeter produces a velocity amplitude of 1 cm. per second.

In a string, a wave motion is described by specifying the displacement of every point as a function of time. To describe wave motion in air, it is usually more convenient to specify the pressure as a function of time and position, since this quantity is more easily measured than the displacement.

*Vibrations of Air in Tubes.* The free plane wave vibrations of air in short tubes resemble very closely the free vibrations of a string bounded at two points. When one end of a tube is terminated by a rigid wall, the displacement must vanish at that wall, so that a displacement node always occurs at the closed end of a tube. This corresponds to a point of maximum pressure. At an open end, the boundary condition is such that the sound pressure must vanish, so that the displacement has a maximum value here. The free vibration of air in a short tube involves a sinusoidal variation of displacement and pressure with time at one of the natural frequencies of the tube.

A tube open at both ends or closed at both ends can propagate only those frequencies for which the length of the tube is an even multiple of the half wave length.

A tube open at one end and closed at the other has a displacement node (pressure maximum) at the closed end and a displacement antinode (vanishing pressure) at the open end. The fundamental frequency of such a tube occurs when the length of the tube is one-quarter of a wave length; the second natural frequency occurs when the length of the tube is three-quarters of a wave length, and higher frequencies occur when the length of the tube is an odd multiple of a quarter wave length. The forced motion of sound in uniform tubes also parallels very closely the forced motion of a bounded string.

The natural frequencies of a closed or open organ pipe are calculated in the same way as for fixed and free strings, except that the velocity of sound in air replaces the wave velocity on strings. For example, the fundamental natural frequency of an "8-foot closed" organ pipe at 70° F. is $\gamma_1 = c/2L = 1{,}120/(2\times8) = 70$ c.p.s., about two octaves below middle C. An "8-foot open" pipe is one-quarter wave length long at the fundamental instead of half a wave length, so its fundamental is about 35 c.p.s., or three octaves below middle C.

*Plane Wave Motion.* It has been assumed in the discussion above that the particles of the medium were constrained to move in a single dimension by being confined in a long straight tube. Plane wave motion can also occur when a driving pressure is applied uniformly over a large area. The air particles in front of the plane are carried along with it, and a region of high pressure is built up in front of the plane. Near the boundaries of the plane the pressure is somewhat relieved by flow around the edges, but near the center of the plane the air particles can only move directly away from the plane. Thus, in front of the center of a large plane surface, the particles of air are effectively limited to a one-dimensional motion as the plane moves back and forth.

*Motion of Air in a Nonuniform Tube.* More generally, however, motion of the particles can occur in three dimensions. An example of such motion is provided by the behavior of air in a nonuniform tube, with a cross-sectional

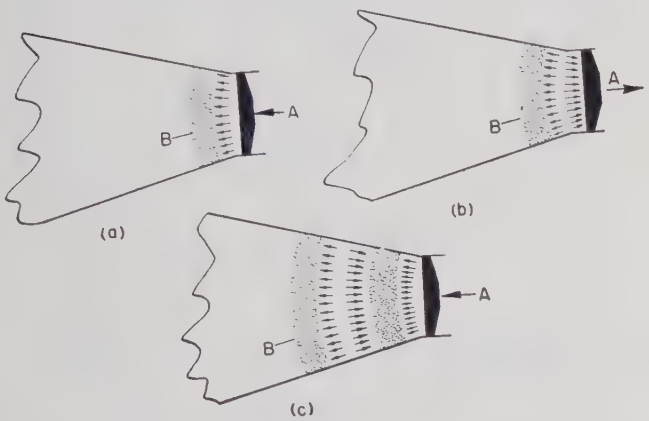



*Fig. 12—MOTION OF AIR IN A NONUNIFORM TUBE*

*(a) Initial high-pressure region created by moving piston*
*(b) High-pressure region moving out, and piston moving in opposite direction*
*(c) Piston creating a second region of high pressure*
*(A) Direction of piston; (B) High-pressure region*

area that changes with distance. Consider a flat piston moving with simple harmonic displacement in the small end of a flared tube, as shown in Fig. 12. As the piston moves forward, the air particles are displaced and a region of high pressure occurs over its face. As the resulting sound wave moves along the tube, the volume occupied by the high-pressure region increases because of the increase in the cross-sectional area of the tube. As a consequence, the maximum pressure in the high-pressure region diminishes as the wave moves along the tube. This reduction in the pressure of traveling sound wave, due to an increase in the area of the wave front, is called geometrical attenuation. Whenever the area covered by a traveling sound wave increases as the wave progresses, the intensity of the wave must decrease, since the product of the area and the intensity remain constant, i.e., the sound energy flowing into any closed volume is equal to the sound energy flowing out of this volume. In the case of a conical horn or of a small source radiating in all directions into free space, the geometrical attenuation causes the pressure to decrease in inverse proportion to the distance from the source, and the intensity is said to vary as the inverse square of the distance from the source.

*Reflection in Three-dimensional Wave Motion.* The phenomenon of reflection is also more complicated in three-dimensional wave motion than in one-dimensional wave motion. In general, reflection occurs whenever a sound wave encounters a surface with a different characteristic impedance. The intensity of the reflected wave $I_R$ depends on the characteristic impedance of the medium $Z_1$ and the characteristic impedance of the reflecting surface, $Z_2$:

$$\frac{I_R}{I_I} = \left(\frac{Z_2 - Z_1}{Z_2 + Z_1}\right)^2 ,$$

where $I_I$ is the intensity of the incident wave. The value of $\rho c$ for air is 42 in c.g.s. units, whereas the value of $\rho c$ for a typical liquid is about $5 \times 10^5$ and for a typical solid, about $1.2 \times 10^6$. Consequently, any continuous surface of a liquid or a solid provides an almost perfect reflector for sound waves in air.

Surfaces that are much larger than the wave length reflect sound according to the familiar law of optics, that the angle of reflection is equal to the angle of incidence. Thus, when a plane sound wave encounters a large smooth obstacle, the direction or directions in which the sound wave is reflected may be determined by thinking of the sound wave as a beam of light and the obstacle as a mirror. However, when any dimension of the reflecting surface becomes comparable in size with the wave length of the sound, the situation is much more complicated. The wave reflected under such conditions, even from a plane surface, is scattered, i.e., reflected simultaneously in all directions.

Since the wave lengths of audible sound in air range from about 50 ft., at 20 c.p.s., to about ¾ in., at 20 kilocycles, common objects of moderate dimensions generally reflect high-frequency sounds like a mirror but scatter low-frequency sounds. Hence, the behavior of a sound wave containing many frequencies when it encounters an irregular obstacle of moderate dimensions is highly complex.

**Radiation of Sound.** In the previous section it is pointed out that a very large plane surface moving back and forth through the air with simple harmonic motion produces a plane wave in front of the central region of the surface. This is a somewhat idealized case, since no actual plane surface can be indefinitely large. To give a complete description of the production of sound, it is necessary to take account of the motion of the air particles around the edges of the radiating surface.

*Simple Source.* Theoretically, edge effects are eliminated only in the case of a sound source having complete symmetry, e.g., a small sphere with a radius that changes sinusoidally with time. Such a "breathing" sphere is called a simple source. Because of the symmetry, the particle displacement at any point takes place along a radial line, and the sound waves move out as spherical surfaces with a constantly increasing radius. As mentioned in the previous section, the sound intensity falls off as the inverse square of the distance from the center of a sphere and the sound pressure falls off as the inverse first power of the distance from the sphere. Any mechanical system which undergoes a periodic change in volume can be considered a simple source for sounds which have wave lengths much longer than the maximum dimension of the system. Thus, at a frequency of 100 c.p.s., a loudspeaker mounted on one surface of an airtight box, 12 in. on a side, is effectively a simple source, since the wave length, 11 ft., is considerably greater than the dimensions of the source, 1 ft.

*Directionality.* Suppose now that two simple sources are located near each other, as shown in Fig. 13; that they are changing in volume by the same amount and at the same frequency; and that they both have maximum volume at the same time. Each source radiates a spherical wave and, by the principle of superposition, the sound pressure at any

point is the sum of the pressures due to each source independently. In some directions, the pressure maximum in the wave train from one source arrives at the same time as the pressure maximum in the wave train from the other source, so that the two waves add together to give twice the value of

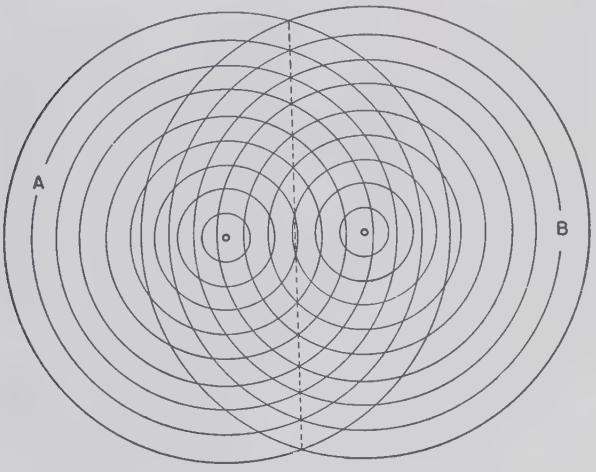



*Fig. 13—INTERFERENCE PATTERN OF TWO SOURCES OF EQUAL AMPLITUDE*

*(A) Wave fronts from left-hand source; (B) Wave fronts from right-hand source*

the pressure of either source independently. In other directions, however, the pressure maximum from one source arrives at the same time as a pressure minimum from the other source so that the two sources cancel each other completely in these directions. The distribution of sound around

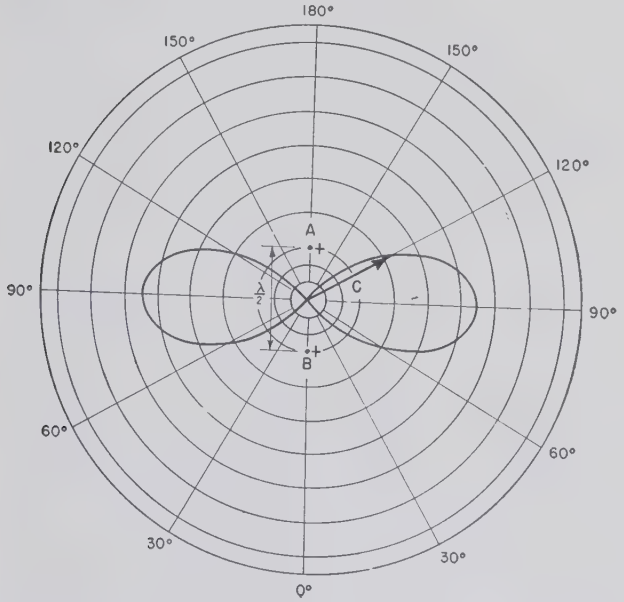



*Fig. 14—DIRECTIVITY PATTERN OF TWO SOURCES IN PHASE AND HALF-WAVE LENGTH APART*

*(A and B) Two sources; and (C) Intensity of sound radiated to a particular point on the curve*

the two sources now has directionality, since the intensity of the radiated sound depends on direction. When two equal sources in phase with each other are located half a wave length apart, the intensity of the radiated sound varies with direction in the manner shown in Fig. 14; two out-of-phase sources located half a wave length apart behave as shown in Fig. 15.

Very complicated directionality patterns can be obtained by various arrangements of the phase relations and the separations between a small number of simple sources. Such a planned arrangement of sources is called an array.

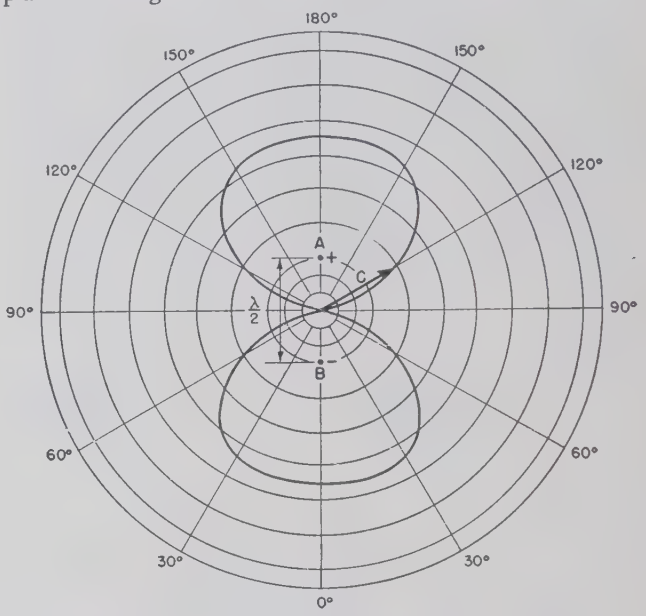



*Fig. 15—Directivity pattern of two sources 180° out of phase and half-wave length apart: (A and B) Two sources; (C) Intensity of sound radiated to a particular point on the curve.*

*Effect of Source on Radiation.* In many cases of interest, however, the dimensions of a source are comparable with the wave length of the radiated sound. This is true, for example, of a 10-in. loudspeaker operating in the frequency region between 500 and 2,000 c.p.s. ($\lambda$=2 ft. to 6 in.). In such cases, the directivity of the radiated sound depends, in a very com-

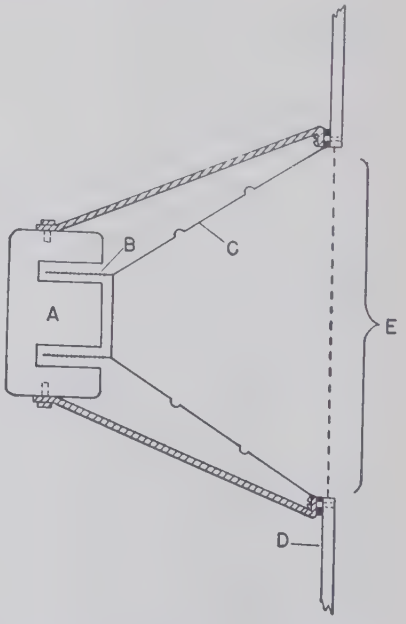



*Fig. 16—Details of a dynamic speaker; (A) Magnet; (B) Coil; (C) Cone; (D) Large baffle; (E) Equivalent piston.*

plicated way, on the ratio of the dimensions of radiator to the wave length, and on the arrangement and size of any reflecting surfaces in the neighborhood of the radiator.

Loudspeakers are frequently mounted in a large, flat re-

flecting surface (a baffle). In this arrangement, the speaker is approximately equivalent to a plane piston moving with the same volume displacement as shown in Fig. 16. The directionality of the speaker can be calculated, within this approximation, by considering every point on the surface of the piston to be a simple source and adding together the contributions from the entire collection of simple sources.

The directionality of high-frequency radiation can be noticed easily with a conventional radio or phonograph. The low-frequency sounds are more or less uniformly spread around a room, but the high frequencies, which contribute to brilliance, are concentrated directly in front of the loudspeaker. Flared and sectionalized horns (tweeters) are sometimes used to spread high-frequency sounds more widely.

At a given frequency, the total power radiated depends directly on the area of the radiating surface. At low frequencies, when the wave length is large compared with the radius, all sources are relatively poor radiators. In order to increase the total power radiated and to decrease the frequency at which the wave length is comparable with the diameter, dimensions of a radiator should be as large as possible. The effective size of a radiator is frequently increased by the use of a horn. In a small, partially closed speaker, such as the one shown in Fig. 17, it is possible to develop relatively high sound pressures. A horn, arranged as shown, distributes this pressure uniformly over a relatively large area and, thus, provides a more efficient radiator than a speaker unit alone.

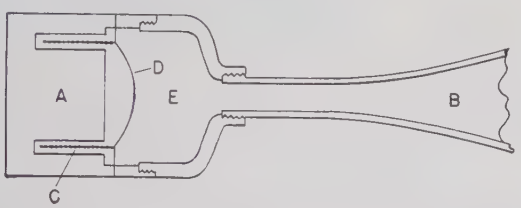



*Fig. 17—Dynamic speaker coupled to an exponential horn: (A) Magnet; (B) Horn; (C) Coil; (D) Diaphragm; (E) Air volume.*

*Effect of Radiation on Source.* Only the effect of source shape and dimensions on the radiated sound have been considered. An additional aspect of the general question of radiation lies in the effect of the radiation on the source. In general, sound sources consist of lumped mechanical or electromechanical systems, and the motion of these systems may be treated by the methods described under Simple Vibrating Systems. However, when a mechanical system radiates sound energy, this fact must be taken into account in the description of the mechanical motion, since the mechanical and the acoustical aspects of the problem are intimately coupled.

The effect of radiation on a mechanical system is to add a radiation impedance to the previously existing mechanical impedance of the system. In terms of the mechanical system, the added impedance is given by the area of the radiating surface times the acoustic impedance at that surface. When the radiated sound is transmitted away from a simple source, the impedance added to the mechanical system is a pure resistance, but when reflecting surfaces, tubes, or horns are used as part of the radiating system, the radiation impedance added to the mechanical system may include an effective stiffness or an effective mass as well as a resistance. *See also* Acoustics; Ultrasonics; Vibration.

R. H. Bo. and R. W. R.

**SOUND-RECORDING SYSTEMS.** *See* Acoustics (*Electroacoustics*).

**SOUND SYMBOLISM,** also called *symbolic phonetics,* that correspondence between the sound and meaning of words which lies outside the realm of onomatopoeia, or sound imitation. The reasons for a correspondence of this kind are not clear, but the phenomenon is so widespread and attested by so much material from all languages that its existence is undeniable.

Ferdinand de Saussure observed that Latin adjectives indicating diseases or deformities of the body contain almost regularly the vowel *ă* (e.g., *caecus, calvus, claudus, crassus, laevus, paetus, parvus, paucus, paulus, plautus, raucus, scaevus,* etc.). This is true not only in Latin, but in Primitive Indo-European too; and it may be added that the vowel *ă* is very rare in that language and that it is outside of the general vocalic system, since it does not take part in the general apophony of all other vowels. There is no question of onomatopoeia in this case, nor can it be said that sick or deformed persons have any preference for the vowel *ă,* or that *ă* is in any other way connected with disease or deformity. The fact remains unexplained, but its existence is well established.

Another clear case of symbolism is presented by *č* (written *tsch*) in German. This sound is entirely outside of the phonemic system of German consonants; it does not go back directly to any Indo-European sound either through Grimm's Law or Verner's Law, and it did not exist in Old High German. It crept slowly into Middle German in a few words of French origin, reproducing the French *ch,* which was at that time pronounced *č* (e.g., *tschevalier, tschamber,* from French *chevalier, chambre*). In Modern German the sound is rather frequent, occurring not only in words of foreign origin, such as *Gletscher, Peitsche, Kutscher, Patschuli,* and *Tschech,* but also in German words that are either recent creations or modifications of old German forms. These words may be divided into two classes: onomatopoetic words (e.g., *zwitschern,* "to twitter"; *klatschen,* "to gossip"; perhaps *rutschen,* "to slide") and expressive or affective words, frequently with a pejorative tinge. Among the latter are *Quatsch,* "nonsense"; *Kitsch,* "daub"; *Patsche,* "puddle"; *patschen,* "to slap," "to splash"; *Putsch,* "political outbreak"; the interjections *ätsch! ritsch! ritsch ratsch!* and, in a very different tone, several words meaning "caress" or "fondle," among them *hätscheln, tätscheln,* and *knutschen.* By no stretch of the imagination can onomatopoeia be found in some of the words in this second category.

The same sound *č* has doubtless an expressive symbolic value in other languages, usually indicating, as in German, something despicable. Spanish has the sound in the endings *-acho, -echo, -icho, -ucho,* and the pejorative Italian suffixes *-iccio, -uccio,* and *-accio* have *čč,* which no other suffix has. In all these languages, *č* is also frequent in affective diminutives from personal names, even where the original name does not have the sound, as in German *Tschatzi* (=*Schätzchen*), Spanish *Chabel* (from *Isabel*), and Italian *Cicci, Ciccio* (from *Francesco*). In Spanish, as in German, there is no "etymological" reason for initial *č-* except in a few foreign words, and it is therefore exclusively onomatopoetic or expressive.

The expressive value of the consonant *l* was recognized by Plato, whose ideas on the subject were developed later by Wilhelm von Humboldt and Otto Jespersen. Plato called attention to the presence of the sound in the Greek words for "smooth," "gliding," "sleek," and "glutinous." It is significant that three of these words have the *l* sound in English also, and there are innumerable examples in English of words that express the idea of gliding with this same sound, e.g.,

*flow, flag, flake, flutter, flicker, flurry, flit, fling, fly, flee, float, slide, slip,* etc.).

Perhaps the clearest case of sound symbolism is presented by the vowel *i,* which is frequently found in the words that indicate something small. Plato noticed this phenomenon also, and there is a vast amount of material now available to illustrate it. A few examples are *little, wee, bit, whit, skimpy,* and the Shakespearean *minikin;* for animals or persons, *kid, chick, kitten, shrimp, filly;* and for small objects, *twig, sprig, chip, strip, tip, pip,* etc. The vowel *i* is particularly frequent in diminutive suffixes and pet-names, especially feminines, and this is true in all languages. Thus English has *auntie, baby, laddie, Dolly, Dicky;* Spanish has *animalico, perrito, mujercita, hombrecillo;* Italian has *bambino, animalino, cagnolino;* and Greek has *παιδίον.* It is significant that many of the Romance suffixes are either new creations or, like *-inus,* had another meaning in Latin and became diminutives because of their sound.

As opposed to *i* (and in some degree *u*), the full vowels *a* and *o* frequently indicate something big. As against *-uccio* and *-ino,* Italian has *-accio* and *one.* "Small" is *petit* in French, *chico* or *pequeñito* in Spanish, and *piccolo, piccino,* and even *piccinino* in Italian (all new creations), while "big" is respectively *gros* or *grand, gordo* or *grande, grosso* or *grande.*

This opposition of *i* or *u* to *o* and *a* appears also in many words of the type *ping-pong, chitchat, zigzag, flic flac, kling klang*—a type that is fairly frequent in many languages of the world. In these formations, it is always the first member that has the *i,* the second one the *a* or *o* (always *ping-pong,* never *pong-ping*). There is certainly a connection between this opposition and that found in adverbs and pronouns expressing the concepts *near* and *far.* The word indicating something near usually has the vowel *i,* while the word indicating something far has the more open vowels *a, o,* or sometimes *e* (Eng. *this:that, here:there;* Ger. *dies:das, dieser: jener;* Fr. *ici:là, celui-ci: celui-là;* Sp. *allí: allá,* etc.).

Despite the frequent recurrence of some of these instances of symbolism, it should be remembered that no regularity can be attributed to the phenomenon. Some sounds are symbolic in some words and not in others, as the vowel *i* in English sometimes indicates a small object but often does not; and conversely, objects are not always indicated by a symbolic sound. Thus in English, from the point of view of sound symbolism, the vowels in *big* and *small* should be reversed and those in *thick* and *thin* should be differentiated. Nevertheless, the evidence is sufficient to prove that phonetic symbolism exists, even though it is not found in all the words in which it might be expected to occur.

Sound symbolism may sometimes be found in conflict with the normal processes of phonetic change. Thus, the vowel *i* in Old English *micel* was transformed to the rather open and obscure vowel of Modern English *much,* a sound that better expresses the meaning of the word. Likewise the word *great* had the vowel *i* until the eighteenth century, and doubtless underwent change for symbolic reasons. *Tiny* had once a symbolic *i,* which became *ai* as in all other words of its type (*mine, wine, shrine, mite,* etc.) and thereby lost its expressive value; but women and children have re-established *teeny.* Even *little,* as normally pronounced, is sometimes considered insufficiently expressive and is replaced by *leetle,* with a longer, narrower, and higher *i.*

Poets, and writers in general, use sound symbolism much more than is usually realized. In *Gulliver's Travels,* Jonathan Swift gave the name *Lilliput* to the land of the dwarfs and *Brobdingnag* to the land of the giants; among the giants, Gulliver himself, being small, is called *Grildrig.* Furthermore, it is possible to observe the liquid effects that a multitude of poets have secured by the use of the sounds *l, r,* and *n,* and to be aware of the contrast between the "light" vowels *i, u,* and *e* and the "somber" vowels *o* and *a* when these sounds are abundant in a few lines of verse. A famous example of sound symbolism in French poetry is Paul Verlaine's

*Les sanglots longs*
*des violons*
*de l'automne*
*blessent mon coeur*
*d'une langueur*
*monotone.*

There is also a remarkable contrast between lightness and gloom in the sound of the two following passages from the *Divine Comedy*:

*quale ne' plenilunii sereni*
*Trivia ride tra le ninfe eterne*
*che dipingon lo ciel per tutti i seni . . .*

*Dopo la dolorosa rotta, quando*
*Carlomagno perdè la santa gesta*
*non sonò sì terribilmente Orlando*

Such examples might be multiplied indefinitely. In many cases onomatopoeia undoubtedly plays a part, but some of the effects of sound symbolism in poetry have eluded all efforts to trace them to that source.

Attempts have been made to explain sound symbolism, or at least some of its manifestations, but none of them have been accepted as wholly satisfactory. It has been argued, for example, that small animals make shrill sounds and large animals deeper ones, and that this explains the opposition *i:o* (*a*). Jespersen suggested that a high-pitched vowel may, as in certain African languages, be associated with small things, and a low-pitched vowel with large things. It has also been pointed out that some vowels require larger openings than others, whether between the lips or in the oral cavity, *a* and *i* being at opposite extremes. Furthermore, the relation of the couple *i:o* (in *ping-pong, ding-dong,* etc.) to the opposition *near:far* has been explained on the ground that distant sounds are less shrill than those near at hand, and that it is natural for the speaker, when he utters two such sounds in succession, to begin with the one that he feels to be nearer. The problem is further confused by the difficulty of distinguishing, in some instances, between sound symbolism and onomatopoeia.

The phenomena of sound symbolism seem to offer definite support to the ancient theory that language is a natural product, not an arbitrary convention. The concept of symbolism was all but completely discarded during the positivistic period of linguistic studies, but it has regained favor with the rise of A. Meillet and his school. Since the same symbolic phenomena are found all over the world, in the most distant and unrelated languages, they present a remarkable example of a linguistic affinity that is based not on historical contacts or common origin, but on the fundamental identity of the human spirit. G. B.

**SOURIS** [sʊ′rɪs; su′ri′], a port town in Kings Co., Prince Edward Island, Canada, situated on Colville Bay, at the eastern end of the island, 45 mi. east of Charlottetown. It is served by the Canadian National Railways. It has fisheries and is a tourist center and supply point for the vicinity. The town was incorporated in 1910. Pop. 1951, 1,183. D. F. P.

**SOURSOP** [sau′ərsɒp], a small evergreen tree, *Annona muricata,* of the custard-apple family, native to the American

tropics. The tree, which grows as high as 20 ft., is also called guanabana. It is cultivated for its edible fruits which are large, juicy, and dark green, and have short, fleshy spines. These fruits are used for jellies and preserves, and for flavoring beverages. The guanabana is naturalized throughout the tropics. J. C. Wis.

**SOUSA, JOHN PHILIP** [su′sə] (1854-1932), American bandmaster and composer, was born Nov. 6, 1854, in Washington, D. C. In his youth he studied the violin, band instruments, and music theory, and later played for five years in the United States Marine Band. At the age of seventeen he began conducting theatre orchestras and practicing composition in his spare time, and in 1880 his steadily growing reputation brought him the post of bandmaster of the Marine Band. His meticulous rehearsal technique and firm leadership restored the morale, broadened the repertory, and improved the instrumentation of this organization, raising it to an enviable position as a concert and marching band. In 1892 Sousa obtained his release from the Marine Corps and formed his own organization, which he took on tour. After a slow start this group became, under his exacting training, crisp direction, and brilliant showmanship, one of the world's most celebrated musical organizations and made many tours of America, several of Europe, and one around the world.

JOHN PHILIP SOUSA

BROWN BROTHERS

Sousa continued along the lines marked out by Patrick Sarsfield Gilmore to broaden the range of dynamics and tone color of the symphonic band by improvements in instrumentation and personnel. He also composed a great number of marches which, by virtue of their remarkable military vigor, attractive tunefulness, and brilliant instrumentation, brought him the well-deserved title "The March King." Among the most famous of these marches are *The Stars and Stripes Forever* (1897), *Semper Fidelis* (1888), *Washington Post March* (1889), and *King Cotton* (1897). In addition to his marches he wrote ten comic operas, including *El Capitan* (1896), *The Bride-Elect* (1897), and *The Free Lance* (1906), as well as suites, overtures, and waltzes. He was also the author of three novels and books of reminiscences. Sousa died March 6, 1932, at Reading, Pa. C. S. Sp.

**SOUTH, UNIVERSITY OF THE,** an accredited, privately controlled college of arts and sciences and school of theology for men, conducted by twenty-two southern dioceses of the Protestant Episcopal Church. The institution, which is coeducational in the summer session only, occupies an area of 9,350 acres in Sewanee, Tenn., in the Cumberland Mountains. The charter was granted in 1858 and first instruction was offered in 1868, the date of the founding of the College of Arts and Sciences. The Theological School was added in 1878. The degrees offered are the A.B. and the B.S. in liberal arts, the B.D. in theology, and the M.A. The library contains many interesting collections, including the Fairbanks collection on the history of Florida and other Southern states; the Houghteling collection on the Reconstruction period in the United States; and the Hudson Stuch collection on travel and exploration, particularly in Alaska. The local chapter of Phi Beta Kappa was chartered in 1926.

All students must live in the college dormitories. Scholarship aid is generous, and there is some opportunity for self-help. *For statistics see* COLLEGES AND UNIVERSITIES.

J. R. To.

**SOUTH AFRICA, UNION OF.** *See* UNION OF SOUTH AFRICA.

**SOUTH AFRICA, UNIVERSITY OF,** at Pretoria, created by the University Incorporation Act in 1916. Its immediate predecessor, the University of the Cape of Good Hope, was founded by legislative enactment in 1873 and replaced the Board of Public Examiners, established in 1858. The act of 1873 granted the property of the Board to the university council. The University Extension Act authorized the council to hold examinations outside of Cape Colony, and to admit noncolony residents to compete for scholarships and prizes offered by the Council of South Africa. The University amendment acts of 1896 and 1908 increased the membership of the council and enlarged the degree privileges of the university. The Act of 1916 incorporated the University of the Cape of Good Hope and six other colleges—Grey University College (in 1935 the University College of the Orange Free State), Huguenot University College, Natal University College, Rhodes University College, Transvaal University College, and South Africa School of Mines and Technology (also known as University College)—into the University of South Africa, the several collegiate units being known as constituent colleges.

The first University College of Orange Free State (Bloemfontein) was founded in 1885 with departments of arts, commerce and administration, education, law, philosophy and social science, and science.

Huguenot University College at Wellington, Cape Province, was founded in 1898 with departments of education, philosophy, English, African and Dutch languages and literature, domestic science and chemistry. Potchefstroom University College for Christian Higher Education in the Transvaal (Transvaal University College) was founded in 1869 and incorporated in the University of South Africa in 1921. It has departments of arts, divinity, education, science, music, commerce and administration, and social science. Rhodes University College at Grahamstown, Cape Province, opened in 1904.

The University of South Africa acts as an examining body for its constituent colleges. In 1946 the Higher Education Amendment Act incorporated the division of external studies for students from nonconstituent colleges. A. L. H-Q.

**SOUTH AMBOY** [a′mbɔi], a city in northeastern New Jersey, in Middlesex Co., 9 mi. east of New Brunswick, at the mouth of the Raritan River, opposite Perth Amboy, with which it is connected by two bridges. Truck farms are found in the surrounding area. Founded in 1835, it was incorporated as a city in 1908. In 1950 the government was the

mayor-councilmanic type. Important as a transfer point, the city ships by barge to New York and New England large quantities of hard coal received by rail from Pennsylvania. Passenger transportation is provided by the Pennsylvania Railroad and the Central Railroad of New Jersey. Located in the rich clay area, South Amboy has several terra-cotta plants. Other industries produce paint pigment, cigars, and wearing apparel. Pop. 1950, 8,422.

**SOUTH AMERICA,** the southern continent of the Western Hemisphere, the fourth in size among the continents, with an area of approximately 6,846,000 sq. mi., excluding Central America. In shape it is roughly triangular, with the greatest width in the equatorial regions of the north. The northernmost point is Punta de Gallinas, Colombia, at approximately 12° 30′ N. lat. and the southernmost is Cape Horn, Chile, at approximately 56° S. lat. Tierra del Fuego at the southern end of the continent is, outside of the Antarctic, the southernmost land mass in the Southern Hemisphere. South America lies east of most of North America. The most westerly point of the continent, Punta Pariña, Peru, 81° 28′ W. long., is at about the same latitude south as Savannah, Georgia, is north. From the eastern projection of the continent in northeast Brazil, 34° 46′ W. long., the distance across the South Atlantic to Dakar in West Africa is about 1,900 mi., or a little more than half the distance across the North Atlantic from New York to London.

**Political Divisions.** The ten republics of South America, with their approximate areas, are: Brazil, 3,286,111 sq. mi.; Argentina, 1,074,209 sq. mi.; Peru, 482,257 sq. mi.; Colombia, 439,825 sq. mi.; Bolivia, 416,040 sq. mi.; Venezuela, 352,141 sq. mi.; Chile, 286,322 sq. mi.; Paraguay, 150,516 sq. mi.; Ecuador, 101,481 sq. mi.; and Uruguay, 72,172 sq. mi. The three European colonies, British Guiana, Surinam (Netherlands Guiana), and French Guiana in northeastern South America have a total area of about 179,000 sq. mi. In most cases estimates of area contain a considerable margin of error since large parts of the continent have never been accurately surveyed. Island possessions of South American countries include the Galápagos (Ecuador) and the Juan Fernández group (Chile). Along the Caribbean coast of Venezuela are the Dutch islands of Aruba, Curaçao, and Bonaire and the British islands of Trinidad and Tobago, all of which are geologically part of South America. In the South Atlantic off the coast of Argentina are the Falkland Islands, a British dependency claimed by Argentina.

P. E. J.

## HISTORICAL GEOLOGY

**Present Physiographic Regions.** The continent of South America is divided into six major physiographic regions, as follows:

(1) The Brazilian Shield, a large region of Archeozoic and Proterozoic rocks with local areas of younger strata, which extends from the Amazon Basin southward to Uruguay and westward to the Andes Mountains.

(2) The Guiana Highlands, a highly dissected upland composed of old igneous and metamorphic rocks. Before the Paleozoic era they were probably the northern extension of the Brazilian Shield.

(3) The Amazon Basin, a great alluvial plain, extending from the eastern flank of the Andes Mountains and separating the Brazilian Shield and the Guiana Highlands.

(4) The Andes Mountains, a complicated range of folded Paleozoic and Mesozoic strata and intrusive igneous rocks, which extends along the entire western border of the continent from Panama to Tierra del Fuego.

(5) The Orinoco Basin, an alluvial plain extending from the west end of the Amazon Basin northward between the Andes Mountains and the western slopes of the Guiana Highlands.

(6) The Argentine Plateau, extending eastward from the southern Andes Mountains from Paraguay on the north to Tierra del Fuego on the south. It is a low plain to the north but becomes an elevated plateau known as Patagonia to the south.

**Archeozoic and Proterozoic Eras.** During the Archeozoic and Proterozoic eras thick sediments were deposited over the Brazilian Shield. Rocks of the same ages are present in the Guiana Highlands, and it is quite possible that the two areas were covered by the same sea. At the end of the Proterozoic era extensive uplifts and mountain building folded and metamorphosed these rocks and they were subjected to many igneous intrusions. This period of mountain building formed a large upland extending from the Guianas to southern Brazil. Extensive erosion had reduced parts of this upland to a low plain by the beginning of the Paleozoic era.

**Paleozoic Era.** In the earlier part of the Paleozoic era the Andean trough appeared along the west side of the Brazilian Shield. This trough is a persistent structure which was submerged and received marine sediments throughout much of the Paleozoic and Mesozoic eras. Another trough, the Amazon trough, developed along the trend of the present Amazon Basin and connected the waters of the Andean trough with the Atlantic. Occasionally, small marginal seas overlapped the eastern end of the Brazilian Shield and parts of the Argentine Plateau. These conditions persisted through the Devonian period, after which a general uplift of the continent occurred which extended throughout most of the Mississippian period. During the Pennsylvanian and Permian periods the seas reoccupied the Andean and Amazon troughs. At this time extensive continental sands and silts were deposited over much of the Brazilian Shield and the northern part of the Argentine Plateau. Parts of these beds are of glacial origin, indicating the presence of ice sheets in this region during the Permian period. The remains of reptiles and plants found in these continental deposits are remarkably similar to those found in the Karroo beds of the same age in south central Africa. This similarity has caused some geologists to suggest that a land bridge existed across the south Atlantic during the Permian period. At the end of the Paleozoic era another general uplift of the continent caused a general withdrawal of the seas.

**Mesozoic Era.** At the beginning of the Mesozoic era the Andean trough was again depressed and flooded by the sea. Thick marine sediments were deposited in the trough in the Triassic, Jurassic, and Cretaceous periods. The rest of the continent remained above sea level throughout the era, but many continental strata were deposited. In the Triassic period thick terrestrial sands and silts were laid down over parts of the Guiana Highlands, Brazilian Shield, and Argentine Plateau. In the southern part of the Brazilian Shield these beds were covered by extensive lava flows.

During the Jurassic and the early part of the Cretaceous, the only rocks deposited in South America were marine strata in the Andean trough, but in the later Cretaceous another series of continental sands and silts was deposited over parts of the Brazilian Shield and the Argentine Plateau. These extensive deposits contain many dinosaur remains and many fresh-water lake beds.

At the end of the Mesozoic era the thick sediments that had been accumulating in the Andean trough were folded and squeezed to form the Andes Mountains. This period of

mountain building continued into the early part of the Cenozoic era.

**Cenozoic Era.** In the early part of the Tertiary period the seas were very restricted in South America. The elevation of the Andes Mountains prevented any invasion from the Pacific. Two small seas were present at opposite ends of the continent. One of them covered the northern end of the Orinoco Basin in northern Venezuela, and the other covered the southern tip of Argentina. Toward the middle of the Tertiary period the northern Venezuelan and southern Argentine seas increased in size. Beginning at this time a secondary uplift of the Andes Mountains occurred. Erosion of the newly uplifted range caused the deposition of a tremendous amount of terrestrial sands, silts, and clays along the eastern flank of the mountains, the Amazon Basin, and parts of the Argentine Plateau. It is in these terrestrial deposits that so many of the interesting fossil remains of Tertiary mammals have been found.

At the end of the Tertiary period a general uplift of the continent caused a withdrawal of the local seas and a termination of the continental deposition. Many alpine glaciers appeared on the Andes Mountains. This glaciation was more intense in the southern part of the range where, in many places, the glaciers coalesced to form ice fields that extended eastward over parts of Patagonia and westward to the Pacific, producing the fiorded coast of southern Chile by their erosive action. At the present time the continent is still relatively high above sea level and glaciers are still active in the southern Andes. E. C. S.

## SURFACE FEATURES

**Major Land Features.** The major surface features of North and South America are broadly similar in that both have high, relatively young mountains on the west, lower, geologically older mountains on the east, and, between the mountains, extensive interior plains. Along the entire western side of South America are the Andes, which with the highlands of Venezuela form a mountainous continuation along the Caribbean coast, terminating in the island of Trinidad. In the central portion of the continent lie the plains of the Orinoco, the Amazon, and the Paraguay-Paraná-La Plata river systems. Major divisions of the highlands which occupy much of the eastern part of the continent are the Guiana Highlands north of the Amazon, the extensive Brazilian Highlands south of the Amazon, and the dry plateaus of Patagonia which occupy nearly all of the narrow southern end of the continent east of the Andes.

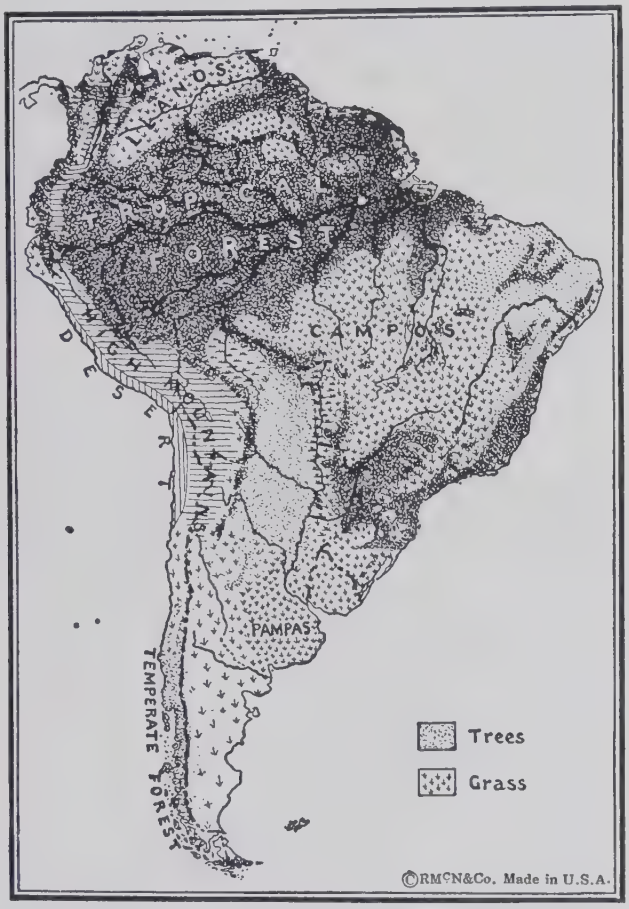
For more than 4,000 mi., from the shores of the Caribbean to the end of Tierra del Fuego, the Andes stand as a barrier between eastern and western South America. They are narrower but considerably higher than the western mountains of North America. Fifty peaks or more reach elevations of over 20,000 ft., and there are very extensive areas lying between 12,000 and 15,000 ft. above sea level. Passes are more than 10,000 ft. above sea level. South America west of the Andes is only a narrow fringe, in most sections less than 100 mi. in width. Along most of the western front of the Andes a foothill belt marks the transition from the Andes to coastal lowland or elevated coastal upland. Along the Pacific coast of Colombia and Ecuador as far south as the Gulf of Guayaquil there is a coastal lowland of swampy grassland, wide alluvial river deltas, and scattered low hills. In the north this lowland extends across the base of the Isthmus of Panama to the Caribbean, separated from the Pacific by the Cordillera del Chocó. From the vicinity of Punta Pariña southward heavy Pacific surf and geologic uplift have produced a coastline of elevated marine terraces and wave-cut cliffs. In some places the cliffs, ranging in elevation up to several thousand feet, drop off directly into the sea, while in others they appear several miles inland with the immediate shoreline occupied by sandy beaches or new marine terraces. Along the northern coast of Peru spurs of the Andes descend gradually to the sea, broken only by small river-built alluvial fans. Low coastal mountains, averaging 3,000 ft. in elevation, appear over most of the distance from southern Peru to southern Chile. In southern Peru they are backed by bleak, rock-surfaced, deeply-dissected pampas which rise gradually to the base of the Andes. Between the coastal range and the Andes in northern Chile is a longitudinal depression occupied by the series of basins which make up the Atacama Desert. From La Serena almost to Valparaiso spurs of the Andes descend to the coast, but southward for hundreds of miles the longitudinal depression appears again as the Central Valley of Chile. In southern Chile the coastal ranges appear as a series of islands and rocky promontories separated by deep fiords and arms of the sea, a region sometimes called the Chilean Archipelago. The Strait of Magellan extends from the Pacific to the Atlantic, separating Tierra del Fuego from the continental mainland.

**Central Plains.** The central plains of South America, composed largely of river- and wind-deposited materials, have in general a gently rolling surface almost entirely under 1,000 ft. in elevation. The plains are neither so extensive nor so continuous as the central plains of North America. The Orinoco plain (the llanos) is separated from the Amazon plain by a belt of highlands. The Amazon plain and the plain of the Paraguay-Paraná-La Plata are continuous in the west along the base of the Andes, where the alluvium brought down from both the Andes and the Brazilian Highlands has covered all but a few of the more prominent features of the underlying rock surface. The Amazon plain, which is wide along the eastern base of the Andes, narrows to only a ribbon of flood plain along the main stream east of Manaus where the river passes between the Guiana and Brazilian highlands.

The llanos of the Orinoco consist of a vast almost featureless savanna-covered plain approximately 600 mi. from west to east and 200 mi. from north to south. It slopes very gradually from the base of the Andes and the Venezuelan highlands to the Orinoco River. Even in the highest part it is little more than 600 or 700 ft. above sea level. The streams which cross it wind about in broad valleys with low gradients. The low mesa-like interfluves between the valleys are the most conspicuous features of the landscape. The area at the mouth of the Orinoco is a rapidly growing, low, swampy delta.

Only a small part of the vast region drained by the rivers of the Amazon system may be described as a plain. Along the lower course of the Amazon only the immediate flood plain is left as a band of lowland between the bordering highlands. Above the junction of the Rio Negro and the Rio Madeira the plain widens out in spatula fashion reaching a north-south extent of some 800 to 1,000 mi. at the base of the Andes. This wide eastern part of the Amazon Basin has been built up by materials brought down from the Andes by the Purús, the Juruá, the Yavari, and the main stream, called Solimões above the Rio Negro in Brazil and Marañón in Peru. About 10 per cent of the Amazon plain consists of river flood plain in which the soils are renewed annually by river-borne silt and the remaining 90 per cent of somewhat higher areas above flood level. The flood plain of the main stream averages about 50 mi. in width though it narrows

to about 20 mi. at Obidos and Santarém near the mouth of the Tapajós. Downstream from the junction with the Rio Xingú the plain widens out, leaving a broad area of lowland at the mouth embracing the island of Marajó and extending northward along the coast to the Guianas and southeastward to the Rio Parnaíba. The flood plain of the Amazon, like the lowlands of the Mississippi, is bordered by valley bluffs between which the river meanders in shifting channels which leave oxbow lakes and swamps.




*AREAS OF VEGETATION TYPES*

**Southern Plains.** The plains of the Paraguay-Paraná-La Plata river systems extend some 1,500 mi. from southeastern Bolivia to La Plata River. Almost all of the area is a vast featureless lowland subject to annual floods. Along the immediate river banks of the Paraguay and Paraná rivers there are natural levees high enough to stand above all but the highest floods. Back of the levees are marshy areas filled with stagnant water which barely drains away even in the dry season. West of the Paraguay River lies the vast alluvial plain of the Gran Chaco, composed of unconsolidated sands and clays brought by rivers from the erosion of the Andes. The Pilcomayo, Bermejo, Salado, and Dulce rivers cross the Chaco with winding, shifting courses, in a pattern of braided channels, crescent-shaped swamps and abandoned levees. South of the area drained by the Paraguay-Paraná-La Plata system but continuous with it are the Argentine Pampas, vast plains, level to gently undulating, mantled to a depth of hundreds of feet by an accumulation of unconsolidated beds of sand, clay, silt, and wind-blown dust, or loess, absolutely gravel free. There are almost no rivers or natural drainage courses. Numerous small ponds and sloughs, salinas in the drier west, dot the landscape.

**Eastern Highlands.** Much the greater part of eastern South America is occupied by highlands, which extend with few interruptions from southern Colombia and Venezuela across Brazil to the northern bank of the Plata and appear again in Patagonia. The highlands have a base of ancient crystalline rocks which forms a hilly upland. Above the hilly upland in a few places appear the stumps of old worn-down mountains with a massive rounded appearance similar to that of parts of the southern Appalachians of the United States. The crystalline bases, especially in the interior, have a cover of stratified rocks which has formed table-like plateaus with steeply scarped margins.

In the Guiana Highlands, lying between the Orinoco and Amazon rivers in Venezuela, the Guianas, and Brazil, the granites and gneisses of the crystalline hilly upland have weathered deeply, producing a thick mantle of fine-grained soils and gently rounded hills. Above the hilly upland in French and Dutch Guiana and along the border of Brazil rise low mountains with steep sides and rounded tops. The most continuous group of such mountains is the Tumucumaque Range, some 3,000 ft. in elevation, which forms the drainage divide between Brazil and French and Dutch Guiana. The stratified sandstones are much more resistant than the granites in the rainy tropics and stand distinctly above the general level of the crystallines with margins marked by steep cliffs. The sandstone plateaus are found in the west, particularly in Venezuela. The highest elevation of the Guiana Highlands is Mount Roraima, with an elevation of 9,219 ft., which is not a mountain at all, but a flat-topped plateau bounded by steeply cliffed sides. Magnificent waterfalls occur where the rivers rising on the sandstone plateaus of western British Guiana fall over the scarped sides.

The same elements appear in the much more extensive Brazilian Highlands. In most of eastern Brazil the base of crystalline rocks is exposed in a surface of rounded, gentle slopes. Scattered over these uplands are many low knobs, groups of hills, and ranges of low mountains composed of quartzites and other types of crystalline rock more resistant than the granites and gneisses. The highest point in Brazil is the Pico da Bandeira, 9,386 ft., on the border between the states of Minas Gerais and Espírito Santo. Relatively high ranges of mountains are the Serra dos Orgãos, northeast of Guanabara Bay, and the Serra de Mantiqueira, on the southeastern border of Minas Gerais. Lower, but significant for its mineral deposits, is the Serra do Espinhaço in the state of Minas Gerais. In northeastern Brazil the highlands rise gradually from the Atlantic coast to the interior, but south of Salvador the coast is backed by a steep wall-like slope, the Great Escarpment, which rises to elevations of 2,600 ft. and more. Generally it is broken into a series of steps, forming parallel escarpments with deep valleys between. Along the coast in São Paulo state, in the section known as the Serra do Mar, the escarpment forms one unbroken slope from the edge of the upland to the sea. Most of the rivers which drain the Brazilian Highlands have their sources in the central and southeastern sections, some at the very edge of the Great Escarpment within sight of the Atlantic. They flow, however, westward or northwestward toward the interior, draining to the Atlantic by circuitous routes through the Paraná, São Francisco, or Amazon systems. Over large areas of inland Brazil the crystalline base disappears under a covering of stratified rocks in the form of table-like plateaus. In northeastern Brazil, the eastern limit of the main sandstone plateaus is a prominent cuesta which runs south-

ward from Parnaíba along the eastern boundary of the state of Piauí. In the stratified formations of southern Brazil and in patches elsewhere occur sheets of dark-colored lava known as diabase. The Paraná Plateau is one of the world's largest formations built of such accumulations of successive lava flows. The diabase is especially resistant to erosion, and the edges of the lava sheets stand out prominently in steep escarpments over which rivers plunge in great waterfalls, as at Iguaçu and Guaíra.

In dry Patagonia the granites and gneisses of the crystalline base are relatively resistant to the processes of erosion and stand out prominently as areas of hilly land surmounting the vast level-topped plateaus. The plateaus, formed of horizontal strata, some of sedimentary origin, some composed of flows of lava, rise like a series of gigantic steps toward the west where the highest tablelands are over 5,000 ft. above sea level.

**Harbors.** The South American coasts offer few good natural harbors. Most of the ports along the more than 2,000 mi. of Pacific coast of Peru and Chile are only partly protected by headlands, and ships must anchor well out beyond the heavy surf and load and discharge cargo by lighter. The largest indentation of the Pacific coast, outside the Chilean Archipelago, is the Gulf of Guayaquil. The port of Guayaquil, a few miles up the Guayas River from the gulf, is accessible to all but the largest vessels. In middle Chile a large crescent-shaped bay protected by a headland to the south made possible the development of Valparaiso as the principal Pacific port of South America. Along the tideless Caribbean coast, sand bars and rapid silting at river mouths necessitate constant dredging at such ports as Barranquilla and Maracaibo. Two of the best harbors on the Caribbean coast are Puerto Cabello and La Guaira, which is artificial, but both are backed by the abruptly rising mountains of the Venezuelan highlands. The northeast Atlantic coast is also marked by silting and sand bars. At Georgetown, British Guiana, the sand bar at the harbor entrance can be crossed only at high tide. Guanabara Bay, formed by a break in the Great Escarpment which allows the sea to come in, gives Rio de Janeiro one of the world's finest natural harbors, but the highland slopes which hem it in render access to the interior difficult and costly. The harbor at Buenos Aires is not natural; this port is maintained only by constant dredging of the low flats of the Plata. Along the desert coast of Patagonia, cliffs at the water's edge and the great tidal range make landing difficult. Only at Puerto Madryn, located on a deep gulf, and at Punta Arenas on the Strait of Magellan is it possible for ships to tie up at docks.

**Rivers.** South America's major navigable rivers have not contributed to the development of the continent as have those of eastern North America. The Amazon, though navigable for ocean-going steamers farther upstream than any other river in the world, traverses a region on which human efforts have so far failed to make much impression. The Orinoco likewise serves an area of very sparse population. The Paraguay-Paraná-La Plata system is marked by shallow waters, sand bars, and shifting channels, and only the lower portions up to Santa Fe are heavily used. The Magdalena, which for some 800 mi. is Colombia's chief artery of transportation, is characterized by a silting mouth, fluctuating water levels, shifting channels, and rapids which must be portaged. Falls and rapids make the rivers which drain the Brazilian Highlands useless for navigation, except for the São Francisco which is navigated with difficulty for hundreds of miles above the Paulo Afonso Falls, a series of three waterfalls which lie between Alagoas and Baía states.

## CLIMATE

Three-quarters of South America lies within the tropics, but, contrary to popular beliefs, all tropical climates are not unhealthful and all tropical climates are not alike. Tropical South America includes regions of such varied climatic conditions as the cool, cloudy desert of the Peruvian coast, the snow-capped peaks of the Andes, the hot and rainy Guiana

*AVERAGE ANNUAL RAINFALL*

coast, the dry Caribbean coast of Venezuela, and the highlands inland from Rio de Janeiro where winters are moderate in temperature and relatively dry. The effects of location in terms of latitude, or distance from the equator, are modified by such other major controls as ocean currents, the direction of prevailing winds, high and low pressure areas, size and shape of land masses, mountain barriers, and altitude.

**Pacific Coast.** Along the Pacific coast there is a succession from north to south of hot wet climate (Colombia and northern Ecuador), cool, often cloudy, desert (southern Ecuador, Peru, and northern Chile), a mediterranean climate of cool dry summers and mild wet winters (middle Chile), and a perpetually stormy, cool and rainy climate (southern Chile). Major factors are the warm waters of the Pacific Equatorial Counter Current off the coasts of Colombia and Ecuador, the cold Peru (Humboldt) Current which bathes the coast from about 30° S. lat. northward to the Gulf of Guayaquil, and the prevailing westerly winds, the roaring forties, which sweep the southern tip of the continent south of 40° S. lat.

**Eastern Coast.** Prevailing east and northeast trade winds blowing across the warm waters of the Caribbean and Atlantic coasts bring an abundant annual rainfall of 40 in. or more to most of eastern South America north of the mouth

of the Plata. Exceptions are the arid Caribbean strip of Venezuela and an area of irregular rainfall and frequent drought in northeast Brazil. Rainfall of over 80 in. a year is found along the Guiana coast, in the upper part of the Amazon Basin, in scattered spots along the Great Escarpment, and on some of the mountain summits of southern Brazil. Temperatures average above 80° F. in the warmest months along the Caribbean and Guiana coasts (August or September), in the Amazon Basin (August, September, October, or November), and in the Gran Chaco (December or January). The highest extreme temperatures in South America have been recorded along the Caribbean coast and in the Argentine Chaco rather than in areas close to the equator. In the Chaco the difference in temperature between the warmest and the coolest month is nearly 30°, the greatest in South America, while in regions closer to the equator there is little variation in temperature from month to month. It is this lack of any cool season and, in the Guianas and the Amazon Basin, the effects of high humidity which give the equatorial regions a reputation for intense heat. In actual fact, much greater extremes of hot weather are experienced in the North American corn belt during summer heat waves. In the interior of Brazil, inland from Rio de Janeiro and São Paulo, because of the higher altitude, climates are relatively cool, similar to those of the southern Appalachians of the United States.

Buenos Aires and the humid Pampas, located in a transition zone, have weather noted for its variability. Cloudy, warm, and depressing weather is brought by the *norte,* the sultry north wind, and clear, cool, dry weather is brought by the *pampero,* the invigorating wind which comes from the cool south across the Pampas. In general, Buenos Aires has about the same temperature in January, the Argentine summer, as does New York in July, while July temperatures in Buenos Aires are about the same as winter temperatures at Charleston, South Carolina. South of the latitude of Buenos Aires the shape of the continent, a relatively narrow finger projecting into the wide expanse of the southern ocean, is an important factor in temperature conditions. Temperatures are relatively mild, being much lower in summer and higher in winter than those associated with areas of the middle latitudes far distant from the moderating effect of the oceans. Even in Tierra del Fuego, more than 55° south of the equator, winters are not comparable in severity to those of Canada or the northern United States. Although temperatures in January, the warmest month, average below 50°, temperatures in June, the coldest month, average above 32°. Most of Patagonia is desert, the cold waters of the Falkland Islands Current reducing moisture from the Atlantic and the Andes acting as a rain barrier on the west.

P. E. J.

## SOILS

Perhaps less is known generally about the soils of South America than about those of the other continents. Most of them are tropical, except in the southern part. At the very southern tip is a bit of tundra. East of the high mountains in Argentina, there are broad areas of grassland soils, similar to those in North America and Asia. Most important are the nearly black, highly fertile chernozem and similar soils. Actually, in Argentina, many of these soils are sown for grazing, although they could be used more intensively for grains.

West of the mountains, the soils, for a long way each side of the equator, are very dry. A few are irrigated, and probably more could be. The northwest coastal strip contains a variety of tropical soils, some of which are suitable for the production of cacao and other plantation crops. Some of the most abundant food crops are produced from the associated alluvial soils.

Most of the agricultural development in Brazil is in the southern part of the country, on red-yellow podsolic soils somewhat like those in the southeastern United States. Such soils have more clay in the subsoil than in the surface, and are not highly productive when first cultivated; moreover, they are subject to erosion when unprotected by thick-growing vegetation. They can be built up to a high state of productivity, however. Besides these soils, there are others, developed from limestones and highly basic igneous rocks, that are naturally more productive and not so erosive.

The great Amazon Basin is largely unexplored, although a few soil scientists have seen parts of it. There are significant but undetermined areas of ground-water laterite, a very poor soil. Such soil develops on nearly level landscapes having alternating wet and dry seasons. Beneath the leached surface there is a mass of weathered clay that hardens to a slaglike rock upon exposure, or even, sometimes, following the cutting of the natural forest. But there are good soils in the Amazon Basin: alluvial soils along many of the streams, and soils on steep slopes that are continually rejuvenated through washing away of the leached surface and the incorporation of fresh minerals from beneath. Such soils are productive, but when they are placed under cultivation great care must be taken to prevent erosion through the use of terraces, or of nearly permanent mixed cultures.

Certainly there are many millions of acres of soil suitable for farming in South America, especially in the upper basin of the Amazon and in the central part of the continent, provided modern fertilizers and other techniques are used. But little actual study and mapping of the soils have been done, and much of the possible development must await the growth of transportation and industry.

Many casual observers of the luxuriant tropical forest are incorrectly persuaded that its soils are fertile. Sometimes they are. But often the nutrients of such soils are exhausted by a few crops, unless the soils are fertilized, or unless large amounts of compost are used. As in Africa and other tropical countries, many native farmers clear a few acres from the forest, grow a few crops, and then let the soil return again to the forest as they clear more land.

C. E. K.

## MINERAL RESOURCES

Most of the mineral wealth of the South American continent is contained within the rocks of either the Andes Mountains or the Brazilian Shield. The Guiana Highlands and the sedimentary basins along the Caribbean coast are additional districts with valuable minerals. Located between the Andes and the Brazilian Shield, the Argentine Plateau is as yet largely unexplored. South America is most prominent in the production of oil, bauxite, copper, lode tin, nitrate, vanadium, and quartz crystal.

**The Andes Mountains.** The province of the Andes, which extends from northern Colombia to the southern tip of the continent along its western border, consists of both igneous rocks, including recent volcanoes, and sedimentary rocks. Within the sedimentary rocks are occasional beds of coal, but neither the Andes nor South America generally can be considered as having adequate coal resources for domestic needs. On the other hand, the metalliferous deposits of the Andes include some of the great ore bodies of the world.

At the northern end of the province is Colombia. Within its borders are a number of coal fields which had not been extensively developed by 1950. The coal is of Cretaceous age;

# SOUTH AMERICA

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Caribbean Sea
North Atlantic Ocean
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HAITI
DOM. REP.
PUERTO RICO (U.S.A.)
JAMAICA (BR.)
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LESSER ANTILLES
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LEEWARD IS.
VIRGIN IS.
BARBUDA (BR.)
ANTIGUA
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DOMINICA (BR.)
MARTINIQUE (FR.)
ST. LUCIA (BR.)
BARBADOS
ST. VINCENT
GRENADA (BR.)
TOBAGO I. (BR.)
TRINIDAD (BR.)
CURACAO (NETH.)
MARGARITA I.
BAHAMA IS.
GRAND CAYMAN I.
CABO GRACIAS A DIOS
MEXICO
BR. HOND.
GUAT.
HONDURAS
EL SALVADOR
NICARAGUA
COSTA RICA
PANAMA
CENTRAL AMERICA
COLOMBIA
VENEZUELA
ECUADOR
PERU
BRAZIL
BOLIVIA
PARAGUAY
CHILE
ARGENTINA
GUYANA HIGHLANDS
SELVAS
BRAZILIAN PLATEAU
MATO GROSSO
PARECIS
SERRA DOS
GALAPAGOS ISLANDS (ECUADOR)
Tropic of Cancer
Equator
U.S.A.
Miami
Key West
Straits of Florida
Havana
Matanzas
Santa Clara
Cienfuegos
Camagüey
ISLE OF PINES
Nassau
ANDROS IS.
WATLING OR SAN SALVADOR I. (COLUMBUS, OCT. 12, 1492)
Progreso
Mérida
Campeche
Yucatan Channel
Windward Passage
Cap Haitien
Puerto Plata
Santiago
Port-au-Prince
Santiago de Cuba
Kingston
Ciudad Trujillo
Ponce
San Juan
Belize
Flores
Gulf of Honduras
Puerto Cortes
Trujillo
Puerto Barrios
Guatemala
Tegucigalpa
San Salvador
La Unión
Corinto
León
Managua
Bluefields
San Juan del Sur
L. Nicaragua
San Juan del Norte
Limón
Puntarenas
San José
Mosquito Gulf
Colón
Gulf of Darien
CANAL ZONE
Panamá (U.S.A.)
David
PT. NARANJAS
Gulf of Panama
Barranquilla
Santa Marta
Cartagena
Uribia
PT. GALLINAS
Coro
Willemstad
Maracaibo
L. Maracaibo
Barquisimeto
Maracay
Valencia
Caracas
La Asunción
Carúpano
Cumaná
Port-of-Spain
Barcelona
Maturín
Los Teques
Tucupita
Trujillo
Guanare
San Fernando
Barinas
Mérida
Orinoco
Ciudad Bolívar
Morawhanna
Cúcuta
San Cristóbal
Bucaramanga
Arauca
Medellín
Quibdó
Turbo
Turbaco
Turbo
Puerto Carreño
Puerto Ayacucho
Rockstone
Georgetown
Buxton
New Amsterdam
BRITISH GUIANA
Paramaribo
Dam
DEVILS ISLAND
Cayenne
C. ORANGE
SURINAM (NETH. GUIANA)
FRENCH GUIANA
St. Georges
Boa Vista
MARACÁ I.
C. RASO
Amapá
Oiapoque
Bogotá
Manizales
Ibagué
Villavicencio
Buenaventura
MALPELO (COL.)
PT. CHARAMBIRÁ
C. CORRIENTES
Nuquí
TOLIMA (VOL.) 18,438 FT.
Cali
Neiva
Popayán
Florencia
Tumaco
Esmeraldas
C. SAN FRANCISCO
Pasto
Mocoa
Ibarra
Tulcán
Quito
Latacunga
Chone
Portoviejo
Ambato
Tena
Riobamba
CHIMBORAZO 20,557 FT.
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Guayaquil
Cuenca
Azogues
Gulf of Guayaquil
Tumbes
Machala
Loja
Sullana
Piura
PT. AGUJA
PT. NEGRA
Chachapoyas
Yurimaguas
Moyobamba
Chiclayo
Cajamarca
Trujillo
HUASCARÁN 22,205 FT.
Huarás
Huánuco
C. YERUPAJA 21,759 FT.
Puerto Bermúdez
Lima
Callao
Huancayo
Huancavelica
Ayacucho
Cusco
Abancay
Ica
Puerto Maldonado
EL MISTI (VOL.) 19,166 FT.
Arequipa
Mollendo
Moquegua
Tacna
Arica
Pisagua
Iquique
Lake Titicaca
La Paz
Guaqui
Cochabamba
Oruro
Santa Cruz
Sucre
Potosí
Pulacayo
Salar de Caipasa
Corumbá
Cuiabá
Goiás
Anápolis
Goiânia
Campo Grande
Uberaba
Belo Horizonte
Corinto
Diamantina
Mucuri
Montes Claros
Jequitinhonha
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PT. SANTO ANTÔNIO
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PT. BALEIA
PT. MONSARÁS
Ouro Prêto
Vitória
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PT. MUTÁ
Juázeiro
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Penedo
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Barra
Pôrto Nacional
Carolina
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Campina Grande
João Pessoa
Caruaru
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Parnaíba
São Luís
Fortaleza
Baturité
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FERNANDO DE NORONHA I. (BRAZIL)
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C. SÃO ROQUE
Natal
Belém
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Pará
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Pôrto de Móz
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Moura
São Carlos
Mitú
Leticia
Iquitos
São Paulo de Olivença
Lábrea
Pôrto Velho
Rio Branco
Villa Bella
Riberalta
Cobija
Trinidad
Puerto Suárez
Puerto Quijarro
Puerto Pacheco
Encarnación
Asunción
Concepción
Pilcomayo
Formosa
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Corrientes
Posadas
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Puerto Casado
Villa Hayes
Pilar
Humaitá
Coronel Oviedo
Villarrica
Encarnación
Ciudad del Este
Foz do Iguaçu
Guaira
Salto del Guairá
Curitiba
Ponta Grossa
Paranaguá
Antonina
Joinville
Florianópolis
Blumenau
Itajaí
Laguna
Tubarão
Criciúma
Rio Grande
Pelotas
Porto Alegre
Caxias
Santa Maria
Uruguaiana
Santana do Livramento
Rivera
Artigas
Salto
Paysandú
Fray Bentos
Colonia
Montevideo
Maldonado
Punta del Este
La Paloma
Chuy
Rocha
Melo
Treinta y Tres
Durazno
Tacuarembó
Rivera
Río Negro
Bahía Blanca
Mar del Plata
Necochea
Tandil
Olavarría
Azul
Tres Arroyos
Puerto Belgrano
Buenos Aires
La Plata
Quilmes
Avellaneda
Lanús
Lomas de Zamora
Morón
San Isidro
Tigre
San Fernando
Zárate
Campana
San Nicolás
Rosario
Santa Fe
Paraná
Concordia
Gualeguaychú
Entre Ríos
Victoria
Gualeguay
Nogoyá
Diamante
Villaguay
Concepción del Uruguay
Colón
Paysandú
Salto
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Tacuarembó
Durazno
Florida
Canelones
Montevideo
Maldonado
Rocha
Treinta y Tres
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Artigas
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Paysandú
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Colonia
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LETTERS AND FIGURES IN RIGHT HAND COLUMN OF INDEX ARE THE LOCATION KEYS. THE CORRESPONDING LETTERS AND FIGURES APPEAR IN THE MAP BORDER BETWEEN LATITUDE AND LONGITUDE LINES WHICH FORM THE REFERENCE ZONES.

Statute Miles 100 0 100 300 500 700
Kilometers 100 0 100 300 500 700 900 1100

Sinusoidal Projection
SCALE 1 29,465,000 1 Inch = 465 Statute Miles

## SOUTH AMERICA

Area . . . 6,846,000 sq. m.
Population . . 111,400,000

KEY TO MAP SYMBOLS

- ⊛ Capital
- • Size of symbols and type indicates relative population.

POLITICAL DIVISIONS

ARGENTINA . . . . . G 5
Area . . . . 1,074,209 sq. m.
Pop . . . . . 16,104,929

BOLIVIA . . . . . E 4
Area . . . . 416,040 sq. m.
Pop . . . . . 3,019,031

BRAZIL . . . . . F 6
Area . . . . 3,286,111 sq. m
Pop . . . . . 51,973,727

BRITISH GUIANA . . . . . C 5
Area . . . . . 83,000 sq. m.
Pop . . . . . 375,701

CHILE . . . . . G 3
Area . . . . . 286,322 sq. m.
Pop . . . . . 5,389,554

COLOMBIA . . . . . C 3
Area . . . . . 439,825 sq. m.
Pop . . . . . 10,544,670

ECUADOR . . . . . D 3
Area . . . . . 101,481 sq. m.
Pop . . . . . 3,202,757

FALKLAND ISLANDS . . . . I 5
Area . . . . . 4,618 sq. m.
Pop . . . . . 2,600

FRENCH GUIANA . . . . C 5
Area . . . . . 35,135 sq. m.
Pop . . . . . 28,537

PARAGUAY . . . . . F 5
Area . . . . . 150,516 sq. m.
Pop . . . . . 1,182,877

PERU . . . . . D 3
Area . . . . . 482,257 sq. m.
Pop . . . . . 7,991,777

SURINAM (Netherlands Guiana) . . . . . C 5
Area . . . . . 54,300 sq. m.
Pop . . . . . 207,684

URUGUAY . . . . . G 5
Area . . . . . 72,172 sq. m.
Pop . . . . . 2,202,936

VENEZUELA . . . . . B 4
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Pop . . . . . 5,091,543

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some of it is coking coal. Colombia is the only South American country to produce platinum and emeralds.

Farther to the south is Peru. In its sedimentary rocks occur both coal and oil deposits in relatively minor amounts. Still producing copper, as well as lead in substantial quantity, the Cerro de Pasco mine high in the Andes was at one time one of the leading copper producers in the world. The greatest vanadium mine, the major source of the world's vanadium for many years, is at Minas Ragra in Peru at an elevation of 16,500 ft. Although South American mercury production has become negligible, the Huancavelica district was at one time an important source. Likewise in the early days of exploration and exploitation Peru was a major source of gold and silver.

That part of the Andean province located in Bolivia contains the largest known lode-tin deposits in the world. Occurring in a mineralized zone about 60 mi. wide and 500 mi. long, the tin ores are associated with tungsten, silver, and copper. Bolivia also has stood high in antimony production, and although individual deposits are small, it is believed a considerable reserve exists.

Chile is one of the leading coal producers of South America and has reserves estimated at 2,000,000,000 tons. It is most noted, however, for its enormous copper deposits located at Chuquicamata, Potrerillos, and Braden. At Chuquicamata, 90 mi. east of the coast, is perhaps the world's largest, with over 1,000,000,000 tons of known reserve. Chile is also the leading source of natural nitrate, which occurs in an impure rock known as caliche in the arid intermontane valley, the Atacama Desert, which lies between the coast range and the Andes. Volcanic sulphur, commercial exploitation of which began in 1935, is also abundant. Other mineral resources include some iron ore and manganese.

The eastern slope of the Andes in southern South America is in Argentina. Tungsten deposits are scattered along the belt for a considerable distance, and lead is produced in the Aquilar district in sufficient quantity to make Argentina self-sufficient in this metal. Zinc in substantial amounts is associated with the lead.

**Brazilian Shield.** The Brazilian Shield is a large area in eastern South America underlaid by rocks of Pre-Cambrian age. It is an upland and plateau country, separated from the Andes by the low-lying Argentine Plateau. During World War II the Brazilian Shield was of utmost importance as a source of quartz crystal used in the construction and operation of radio and allied detection devices. Another strategic mineral produced in quantity is sheet mica. Industrial diamonds have been mined in Brazil since the eighteenth century. Until the richer deposits of India were discovered, the Brazilian seashore sands supplied the world with monazite, the ore of thorium. There remains, however, a large reserve of raw material for atomic energy in the monazite sands of the Brazilian coast.

One of the largest deposits of high-grade iron ore known in the world is in Minas Gerais, Brazil. Although it contains an enormous quantity of 70-per-cent iron ore, there is no near-by coal supply for smelting, so that the ore has to be shipped abroad for conversion to metal. Minas Gerais also contains high-grade deposits of manganese ore, which is mined in considerable quantity at Ouro Preto. The reserves are plentiful. Manganese is exported from Brazil to the United States in increasing volume. In the southern part of São Paulo, Brazil, a number of deposits of silver-lead ore were discovered and developed during the early years of World War II.

**Guiana Highlands.** The Guiana Highlands are geologically similar to the Brazilian Shield, but are separated from it by the alluvial valley of the Amazon. The climate, warm and humid, causes more rapid weathering processes in the Guianas than in the more temperate Brazilian Shield, a fact which has produced enormous deposits of bauxite, the ore of aluminum, in Surinam and British Guiana. These deposits are the major source of raw material for aluminum manufacture in the United States and Canada.

**Sedimentary Basins Province.** This province is at the northern end of the continent adjacent to the Caribbean Sea. The basins contain a series of thick sedimentary rocks in which prolific amounts of oil have been discovered. At the epicenter of the Maracaibo Basin, covering western Venezuela and eastern Colombia, is Lake Maracaibo. What is perhaps the greatest aggregation of oil fields in the world, one that has been responsible since the late 1920's for Venezuela's rank as second or third among the world's oil-producing nations, is adjacent to the eastern shore of the lake. In eastern Venezuela is the Orinoco Delta, where a number of oil fields have been discovered, and beyond it is the British island of Trinidad, which produces both liquid petroleum and natural asphalt in abundance.

**Argentine Plateau.** This province includes the plains belt located between the Andes and the uplands of the Brazilian Shield. The large volume of sedimentary rocks present in this province is mostly unexplored. Southern Brazil has a small coal-mining industry in an area of Carboniferous rocks. The Argentine Pampas contains a number of relatively small oil fields, and additional fields occur in western Argentina in the Pampas-Andes border zone. The potentialities of oil production in the Chaco region of Paraguay, Bolivia, and Argentina were under exploration and initial development in 1950. K. K. L.

## FLORA

**General Characteristics.** South America, stretching over almost seventy degrees of latitude embracing steaming jungles and scorching deserts to regions of perpetual snow, is one of the richest and most complex botanical regions of the world. Its diversity in topography and climate is reflected in a corresponding multiplicity of vegetation types and in one of the richest of all floras. Many important economic plants come from this area, and the Inca Indians of the Andes were among the most active and successful of all peoples in bringing plants under cultivation.

The flora is incompletely known, but contains an enormous number of species. Tropical regions, in general, have far more numerous species than do temperate, and the greater part of South America is tropical. Since portions of it have been above water from geologically very ancient times, and since the degree of isolation has been extreme, endemism is marked and connections with other floristic regions are relatively slight. The principal relationship is with the floras of Central and North America, to the tropical floras of which it has contributed heavily, receiving certain elements, especially montane ones, in return. Relationship with the Antilles also is close, much of the flora of the latter being derived from South America. A small but very definite common element exists with the flora of western Africa, and the south Andean flora has close connections with that of Australasia.

Floristic regions of more than ordinary interest are the Pacaraima mountain system, between Brazil and Venezuela; the highlands of southeastern Brazil; the Amazonian lowlands; and the Andes. Local endemism is extreme in many areas, but the whole continent is so poorly explored botani-

cally that little of real significance can be said on this subject. A number of families are endemic to the continent, as the Nolanaceae, Malesherbiaceae, Brunniaceae, Brunelliaceae, Thurniaceae, Calyceraceae, Trigoniaceae, and Gomortegaceae. Many others have their principal development there. Some theories suggest South America as the place of origin of the seed plants. Fossil plants are known from various parts of the continent, but South American paleobotany is in its infancy.

**Floristic Regions.** Floristically the continent may be divided very roughly into about twelve regions. These overlap and grade into one another, are complex within themselves, and are difficult to define.

*Coast of Colombia and Ecuador.* The rainy region of the Pacific coasts of Colombia and Ecuador is really a continuation of the Central American rain forest. It also has much in common with the Amazonian rain forest.

*Caribbean Coast.* The dry north coast has a typical Caribbean flora, with thorny Leguminosae, *Bursera, Hura, Crescentia, Tabebuia,* Bombacaceae, and Cactaceae prominent.

*Orinoco Plains.* The plains (llanos) of the Orinoco drainage are grasslands, savannas, and tropical deciduous forest, with numerous grasses, sedges, Leguminosae, and Palmaceae such as *Mauritia* and *Copernicia.* The floristic relationships are primarily to the south.

*Andes.* The Andes, with their tremendous north and south extension, altitude, and topographic diversity, have a rich and complex flora with many highly endemic elements. There are many genera better known from the temperate zones of North America, such as *Lupinus, Castilleja,* and *Viola;* austral genera from the subantarctic regions, such as *Acaena, Gunnera,* and *Drimys;* and numerous derivatives of the surrounding lowland zones. Striking is the development of the Compositae, Campanulaceae, Rubiaceae (including *Cinchona,* source of quinine), Labiatae, Ericaceae, Rosaceae, Orchidaceae, Bromeliaceae, and Pteridophyta, as well as such endemic families as Malesherbiaceae, Brunelliaceae, and Gomortegaceae. An extension of this region may be the Patagonian-Fuegian steppe, of extreme southern South America, even though this is largely at lower altitudes.

*Pacaraima Region.* The poorly explored but fascinating Pacaraima region, a series of flat-topped sandstone mountains on the Brazilian-Venezuelan border, is small in area, but on these summits is an almost wholly endemic flora. This consists largely of archaic relicts of a former flora, the other principal present-day remnants of which are found in the mountains of southeastern Brazil. There is also some slight affinity with the floras of the Andes, the high mountains of the Oriente of Cuba, and the mountains of West Africa. Among the families with outstanding endemics are the Eriocaulaceae, Xyridaceae, Bromeliaceae, Cyperaceae, Ericaceae, Lentibulariaceae, Rubiaceae, etc.

*Amazonian Forest.* The vast forest of the Amazon Basin, though mostly occupying a relatively uniform and recent area, is complex and rich in species. Rubiaceae, Loganiaceae, Myrtaceae, Lecythidaceae, Ochnaceae, Euphorbiaceae, Lauraceae, Moraceae, Palmaceae, and Leguminosae are among the prominent families. The relationships are with the Pacific Coast-Central American and southeast Brazilian rain forest regions.

*Eastern Brazil.* Eastern Brazil is a complex region, mainly forested, but largely with different genera and species than in the surrounding areas, growing under completely different conditions. The northern part of this region is characterized by palm forests with species of *Orbignya, Copernicia, Mauritia, Euterpe,* etc. The caatinga zone is noted for its Cactaceae, as well as for Leguminosae and other families which lose their leaves in the dry season. Floristic relationships are with other dry regions of the continent, as well as with Amazonia and the forests to the southwest.

*Coast of Southeastern Brazil.* The wet coast of southeastern Brazil, the area of Rio de Janeiro, contains an unbelievably rich flora, characterized by numerous species of Rubiaceae, Bromeliaceae, Melastomaceae, Euphorbiaceae, Moraceae, and Myrtaceae. It has much in common with the Amazonian forest and with the west eastern slopes of the Andes.

*Highlands of Southeastern Brazil.* The highlands above and to the west of this coastal strip are characterized by an ancient flora with many Xyridaceae, Eriocaulaceae, Bromeliaceae, Velloziaceae, and Lentibulariaceae. Its closest connections are with the flora of the Pacaraima Mountains. There are also many elements from the surrounding regions.

*Paraná Basin and Argentine Plains.* The Paraná drainage and the Argentine plains are quite diversified in their flora, but form a logical floristic region. Gramineae, Cactaceae, Leguminosae, Anacardiaceae, and Rhamnaceae are prominent families. Here are found the economically important yerba maté (*Ilex paraguariensis*) and quebracho (*Schinopsis* and *Aspidosperma*), and in the northeast is the famous Paraná pine (*Araucaria angustifolia*). The floristic affinities are largely with semiarid and arid regions in more northerly parts of South America, but *Larrea divaricata, Koeberlinia spinosa,* and some other genera and even other species are common to this region and arid southwestern North America.

*Pacific Lowlands.* The desert strip along the western base of the Andes has a relatively small but highly specialized flora. Solanaceae, Nyctaginaceae, Bromeliaceae, Cactaceae, Compositae, Boraginaceae, Leguminosae, Rhamnaceae, Malvaceae, the endemic Nolanaceae, *Capparis,* and such strand plants as *Batis, Sesuvium,* and *Distichlis,* characterize the deserts, lomas, desert scrub, and salt flats of these Pacific lowlands. The relationships are with more northern and inland dry areas, with the tropical strand flora, and with arid southwestern North America.

*South Chilean Forests.* The Fuegian, Magellanic, or south Chilean forests, dominated by *Nothofagus* and southern hemisphere conifers, and forming the most isolated major forest region in the world, has its floristic connections with New Zealand and southern Australia, as well as with the Andes to the north.

**Principal Economic Species.** The forest flora of South America is rich in economic species. *Bertholletia excelsa* produces brazil nuts; *Anacardium occidentale,* cashews; *Theobroma cacao,* chocolate; *Hevea* and *Castilla,* rubber; *Swietenia,* mahogany; *Cinchona,* quinine; *Schinopsis* and *Aspidosperma,* quebracho; *Caesalpinia,* tara, divi-divi, and brazilwood; *Myroxylon,* Peru and tolu balsams; *Copernicia,* carnauba wax; and *Attalea* and *Leopoldinia,* piassava fiber, to mention but a few of the most conspicuous and important. Prominent domesticated plants that originated in South America are beans, pumpkins, squashes, tomatoes, potatoes, peanuts, sweet potatoes, pineapples, red peppers, tapioca, tobacco, barbasco, cacao, guarana, coca, Pará rubber, *Cinchona,* and probably maize. Of these, all but rubber and *Cinchona* were domesticated by the aborigines in prehistoric times. Important exotic plants in South America are coffee, sugar cane, African oil palm, coconut, molasses grass (*Melinis*), other forage and soil-protecting grasses, *Eucalyptus,* wheat, barley, and numerous and varied types of garden vegetables.

**Classification.** The vegetation of South America is complex and often difficult to classify. Much of it falls readily into the three commonly recognized major groups, forest, grassland, and desert, but many intermediate types exist, as well as some which do not fit well into any of them. Such is the type dominated by huge cushion plants in the Andes. Only with difficulty can the Colombian páramo be considered grassland. The *cerradão* of eastern Brazil is not easily placed; it is generally considered a savanna, since it is intermediate between grassland and forest, but it is strikingly different from other savannas.

**Forests.** *Rain Forest.* The forests are of many types. Basic is the tropical rain forest, which occupies enormous areas in the Amazon Basin, the coastal strip of southeastern Brazil, the Guianas, the upper southern tributaries of the Orinoco, the eastern slopes of the central and northern Andes, the middle Magdalena Valley, the Atrato Valley, and the Pacific slopes and lowlands of Colombia and Ecuador. It varies greatly from place to place, ranging from the tall lowland type, with a dense canopy filled with vines, clean tall trunks, and little undergrowth, to montane rain forest on high slopes, with lower stature, great quantities of bryophytes, ferns, orchids, and other plants as epiphytes, and an almost impassible undergrowth. The former type grows either on sterile soils which accumulate little or no humus, or on low flood plains which are under water a part of the year. The montane type usually has a rich humus layer. In the northern Andes the rain forest extends to very great altitudes in places, assuming, of course, a temperate character. Some forests of *Polylepis* and *Gynoxys* reach elevations of 12,000 ft. or more in Colombia and Ecuador.

*Subantarctic Beech Forest.* In southern Chile and around the Strait of Magellan is the *Nothofagus,* or subantarctic beech forest, a temperate rain forest. In its northern portions various Southern Hemisphere conifers and podocarps constitute a large part of it. It is an evergreen forest occurring generally at middle and low altitudes on the rainy west coast, in the belt of the prevailing westerly winds. The position of this forest corresponds to that of the dense wet evergreen forests stretching from Oregon to Alaska in the Northern Hemisphere.

*Palm Forest.* Palm forests are found in various regions, covering small or even extensive areas. The species of palms vary greatly in different regions. Best known and most extensive in area are the forests of *Orbignya, Copernicia, Mauritia,* and *Euterpe* in eastern Brazil. The Andean wax palm (*Ceroxylon*) forms forests in certain high valleys in Colombia. In some areas, as in the Chaco of Paraguay, palms occur in thin stands in grasslands, termed palm savannas.

*Tropical Deciduous Forest.* Tropical deciduous or rainy-green forests, similar to the monsoon forests of the Old World tropics, are found in widely scattered parts of the continent. They are usually in places that are transitional between rain forests, on one hand, and savannas and deserts, on the other. They are characterized by various Leguminosae, Bombacaceae, Meliaceae, Bignoniaceae, and other families that tend to lose their leaves in the dry season. There are usually various epiphytic Bromeliaceae and numerous vines, the latter also deciduous in the dry season. The weird, thickened, and often bottle-shaped trunks of some of the Bombacaceae give this type of forest a picturesque appearance. There are extensive areas of this type in the Chaco of northern Argentina, Paraguay, and Bolivia, and farther north in the Bolivian lowlands and western Brazil, in the caatinga of eastern Brazil, in the valleys of the west slopes of the Andes in Peru, in the deeper inner valleys of the Andes from Peru to Colombia and Venezuela, in the coastal hills west of Guayaquil, Ecuador, in the upper and lower Magdalena Valley of Colombia, along the Caribbean coast, and in the northern and southern parts of the Orinoco Valley plains. Along the Caribbean coasts, in eastern Brazil, and in coastal southern Ecuador, thorny legumes, cacti, and other thorny or spiny plants dominate this type of forest. Wooded tracts in these areas are termed thorn forests.

*Paraná Pine Forest.* In southern Brazil are extensive forests dominated by a picturesque and economically important timber tree, the Paraná pine (*Araucaria angustifolia*). These forests have been so exploited for timber that they are now much more restricted.

**Savannas.** Savanna is a term usually applied in phytogeography to a transition between forest and grassland in the form of open grassy country with scattered trees and patches of forest. The term park land is sometimes applied to it. Being thus transitional, it is an extremely variable formation. Areas corresponding to savannas are found in the plains of the Orinoco, where the term was originally applied; in scattered patches north of the Amazon; in large sections of the campos of south central and southwestern Brazil, especially in the Mato Grosso; in the Chaco; in northern and central Argentina; and in Uruguay. In the last it is intermingled with large sections of pure grassland. There is little doubt that in many or most regions the savanna is the result of fire and is maintained by both fire and grazing.

**Grasslands.** True grasslands of a prairie type, known as the Pampas, occur principally in the La Plata region of Uruguay and Argentina, and just to the south of that area. The Pampas are rich plains of loess soil, dominated by tall grasses, and are the basis of most of Argentina's wealth. They are ideal agricultural land. Consequently there are almost no stands of this vegetation in its original state.

The meadows above the timber line in the Andes, especially in Peru and parts of Bolivia, including the famous two-mile-high Altiplano around Lake Titicaca, also form extensive grasslands. In the south, from central Peru to central Chile, the *puna* type is a dry steppe, dominated by several harsh xerophyllous species of *Stipa,* while in northern Peru and Ecuador the *jalca* type is much wetter and has a more varied flora. Cushion plants of various sorts are dominant locally in all of these high regions. In northern Ecuador, Colombia, and Venezuela the meadows are dominated by the fantastic frailejon (*Espeletia*), a genus of the Compositae with large, conspicuously woolly leaves in great rosettes, either acaulescent or on erect postlike stems. These meadows are termed páramos, and are the home of a rich endemic flora with many gorgeous flowers. In the páramos of the Sierra Nevada de Santa Marta and of the Venezuelan Andes are found vegetable sheep (*Rauliopsis*), another composite genus, so woolly that the clumps of plants resemble small sheep. Vegetable sheep are otherwise known only in New Zealand. The different characters of these three types of mountain meadows seem to be correlated with the fact that they become dryer to the south.

**Desert Vegetation.** The Patagonian-Fuegian Steppe, in many respects, is an extension of the high altitude vegetation of the Andes, covering the southern extremity of South America east of the *Nothofagus* forests, even down to the low plains. It is a dry, cold, treeless desert, dominated by harsh grasses, rosette plants and cushion plants. Because of the extreme southern latitudes, somewhat the same condi-

tions prevail as at higher altitudes farther north. The area is also mostly in the rain shadow of the Andes.

North of this, from the east slopes of the Andes to the Atlantic coast of Argentina and the savanna west of the Pampas, extending north to the Chaco, is an extensive desert scrub formation. It is in the rain shadow of the Andes in the horse latitudes and the northern part of the prevailing westerlies belt. This vegetation, known as *monte occidental,* is a sparse xerophyllous type, with shrubs or low trees widely spaced. The creosote bush (*Larrea divaricata*), also dominant in the North American desert scrub, is common or dominant here.

Another type of scrub is the *tola* heath of the Altiplano of Bolivia and southern Peru. It is practically a pure stand of the genus *Lepidophyllum.* Other dry rocky areas in and around the Altiplano are dominated by huge woody species of the curious cushion plant, genus *Azorella,* called *llareta* or *yareta* locally. Both *tola* and *yareta* are important local fuels because of their high resin content and the absence of other combustible materials.

The narrow strip between the Andes and the Pacific, from north central Chile to the northern border of Peru, including the famous Atacama Desert and the Chilean nitrate beds, is one of the most extreme deserts in the world. Great areas are completely devoid of vegetation. Other areas have a low gray covering of several extremely xerophytic *Tillandsia* species. At the mouths of deep valleys emerging from the Andes are strips of vegetation running to the sea, supported by underground water draining from the mountains. Here are *Prosopis, Vallesia,* and *Tessaria,* as well as *Distichlis* and other grasses. Most of these areas are under irrigation and are Peru's most productive agricultural lands. In this desert the coastal hills, when bathed by periods of heavy fog or after the rare rains, sometimes many years apart, produce the remarkable loma vegetation. During a foggy season or after a rain, a covering of herbs appears, consisting of ephemeral annuals and tuberous rooted perennials, where before there had been nothing but bare ground. Many bright colored flowers, especially of the endemic family Nolanaceae, are found here. The lomas in central and southern Peru, as well as those around 26° S. lat. in Chile, are more dependent on fog, and develop more frequently, while those in northern Chile and northern Peru depend on rain and very rarely produce vegetation. Other large areas in this region have a very sparse scattering of *Prosopis,* cacti, and tree *Capparis.* The last is especially common in sandy places, where it acts as a dune binder. Toward the coast, in saline areas, are *Distichlis, Grabowskia, Baccharis,* and in the north the endemic *Cryptocarpus.* Immediately adjacent to the coast such strand succulents as *Batis* and *Sesuvium* have assumed dominance in places. Judging from the archeological remains, terraces, canals, fortifications, and so on, the land in this region under irrigation and human occupation in the time of the Incas and pre-Incas was much more extensive than now. This whole desert is the result of the proximity of the cold Peru Current off the coast. The current cools the sea air, which constantly flows toward the warmer coastal plain, bringing no available water with it for the lowlands and the lower western Andean slopes.

**Mangrove Formations.** The only other major vegetation type is the mangrove formation. This consists of a number of genera of trees especially adapted to growing in salt-water mud flats and estuaries. Many are equipped with extensive systems of prop roots, others with pheumatophores, apparatus for aerating the roots, which are usually submerged in still water. This formation occurs wherever there are extensive estuaries, a low or sinking coastline, or tidal flats in the tropical part of the continent, and is frequent from Ecuador to Panama on the Pacific side, and along the Caribbean and down the Atlantic coast to southern Brazil. F. R. F.

## FAUNA

**Origins and Relationships.** From the standpoint of zoogeography, South America forms the greater part of the Neotropical region, which includes, in addition, Central America, the West Indies, the lowlands of Mexico extending into Texas, and the coastal strip of Florida. Most of the South American fauna is of indigenous origin, but there is an important element which has descended from North American immigrants. There also are many interesting relationships between the faunas of the Neotropical, Ethiopian, and Australasian regions. These involve common fauna which are not extant in the northern continents, and about which varying theories of origin have arisen. On one hand, numerous land bridges have been visualized to account for their migrations from one region to another; on the other, they have given rise to the thesis that the cradle of mammalian life, at least, was in the northern continents, whence the primitive and usually less successfully specialized groups were pushed slowly into the southern continents as new waves of more aggressive and successful mammals appeared.

**Mammals.** The marsupials, characteristic of Australasia, are more abundant in South America than in the only other continent where they occur, North America. There are two families, the Didelphidae and the Caenolestidae. Of the didelphids, or opossums, there are at least three genera containing sixteen or seventeen species. The second family, the surviving remnant of a once very extensive and widespread group, is represented by *Caenolestes,* found in Ecuador, Colombia, and Peru.

Although continental South America has no representatives of Insectivora, the shrew, *Blarina,* is found in Central America. In Cuba and Haiti are found two species of an especially noteworthy insectivore, *Solenodon,* the nearest relatives of which are the tenrecs, *Centetes,* of Madagascar.

Perhaps the greatest contrast between the faunas of North and South America is that afforded by the Primates. North America has no monkeys and has had none for ages past, whereas there is a great variety of them in the tropical forests of South America. Indeed, South America ranks second in the number of primate genera, Africa having twenty-five and the Neotropical region fourteen. The Neotropical primates are representative of two families, the Hapalidae, or marmosets, and the Cebidae. The marmosets are the smallest of the monkey tribe and differ from all other monkeys in several features. The most conspicuous are the long claws on the feet and the nonopposable thumbs. The second family, the Cebidae, consists of the spider monkeys which, while superficially resembling those of the Old World, are very different in detail and are readily distinguished from them by their prehensile tails. In this family are the spider monkey, *Ateles;* the capuchin monkey, *Cebus;* the red howler, *Mycetes;* the saki, *Pithecia;* and the douroucolis, *Nyctipithecus.*

Just as Africa is a major center of insectivorous adaptive radiation, South America is one of the most important centers of rodent diversification. It is the center of the porcupine group, *Hystricomorpha,* of which there are at least twenty-nine indigenous genera. This variety of porcupines is in striking contrast to the sole North American representative, the Canadian porcupine, *Erethizon.* Among the many interesting hystricomorphic rodents are two genera of arboreal

porcupines which have long, prehensile tails: *Coendou* and *Chaetomys.* The coypu, *Myocastor,* is a large aquatic animal resembling the muskrat. The chinchillas (*Chinchilla* and *Lagidium*) of the Andes, the cavies (*Cavia*), and the Patagonian hare (*Dolichotis*) are typical South American hystricomorphs. The water hog, *Hydrochoerus,* an aquatic animal about the size of a pig, is the giant of the entire order Rodentia. Still another family of hystricomorphic rodents consists of the paca, *Cuniculus* and the agouti, *Dasyprocta.*

The remainder of the rodents in the Neotropical region are of northern origin and constitute a much smaller number of families and genera than in North America. There are very few species of rabbits; one is found in Brazil, and another in Costa Rica. True arboreal squirrels are present, but there are no ground squirrels, i.e., chipmunks, marmots, prairie dogs, and beavers. There is only one family of mice. The Carnivora are especially well represented in South America. The Felidae are represented extensively by the jaguar, *Felis onca,* which ranges from Central America into southern South America; the puma, *F. concolor,* occurring from British Columbia southward almost to Cape Horn; and the ocelot, *F. pardalis,* which is plentiful in the tropical regions of South America.

There are no true wolves or foxes in the region, but there are several species of canids not found elsewhere: *Icticyon venaticus, Canis microtus,* and *Cerdocyon thous.*

The weasel family is represented by two skunks, *Conepatus* and *Spilogale;* the grison, *Galictis;* the tayra, *Tayra;* and several species of otters, *Lutra.* The raccoons are especially well represented in South America. Typical members of the family are the coati, *Nasua,* and the kinkajou, *Cercoleptes.*

South America has only one genus of bears. This is the spectacled bear, *Tremarctos,* of the highlands of Peru and Chile. The only living perissodactyls of the Western Hemisphere are the tapirs, *Tapirus,* which are widely distributed throughout the warmer regions of South America.

Although their numbers are small when compared with the Old World, the artiodactyls are well represented. The peccaries, *Dicotyles,* range from Texas through Central America to Paraguay. Outstanding among the South American artiodactyls are the members of the camel family. Neotropical forms are the llama, *Lama glama;* the alpaca, *Lama pacos;* the guanaco, *guanacus;* and the vicuña, *Lama vicunna.*

True ruminants are represented in the Neotropical region only by deer, of which there are several genera shared with North America. The Virginia deer, *Odocoileus,* of the northern United States, extends through Mexico and Central America to Guiana and Peru. Peculiarly Neotropical are the diminutive brockets, *Mazama,* which seldom exceed two feet in height and have simple spikelike antlers not more than three inches long. The Chilean pudu, *Pudu,* is the smallest of all deer.

With the exception of one armadillo which has invaded Texas the Xenarthrous edentates are entirely confined to the Neotropical region. The armadillos are represented by three genera, *Priodon, Lysurius,* and *Chlamydophorus.* Included among the South American edentates are the ant bears, *Myrmecophaga;* the diminutive anteater, *Tamandua;* and the sloths, *Bradypus.* Both the sloths and the anteaters are forest animals, and are tropical or subtropical in distribution.

**Birds.** The Neotropical avifauna includes, as in all other southern zoogeographical regions, a representative of the ratites, the rhea, *Rhea.* Among the gallinaceous birds, South America has the curassows, *Crax,* and the guans, which are closely related to the brush turkeys of the Australasian region. The hoatzin, *Opisthocomos,* somewhat resembles the guans, but has some features that appear to associate it with the rail and cuckoos. Although the storks are, in general, confined to the Palaearctic and Oriental regions, there is one representative of the group in South America, the jabiru, *Ciconia.*

Closely allied to the ducks are the South American screamers, which form only one family and an order, Palamedeae, in themselves. The Derbian screamer, *Chauna chavaria,* is one of the best known species. There are several outstanding Neotropical swans, *Cygnus,* including the black-necked and the coscoroba swans.

Probably the most characteristic South American bird is the condor, *Sarcorhamphus,* of the Andes. This huge turkey vulture is the largest of the flying birds. Another characteristic member of the Cathartidae is the black turkey vulture, *Catharistes,* which ranges through Central America. Another of the Neotropical birds of prey is the huge and fierce harpy eagle, *Harpia harpyja,* of Central and South America.

The hummingbirds, although restricted to the New World, are not confined to the tropical regions, but the majority of the approximately five hundred species are natives of Central and South America. Some may be seen on the wing in snowy weather in Tierra del Fuego, and some frequent the vicinity of perpetual snow in the Andes of Ecuador at a height of at least 16,000 ft. The largest species, *Patagona gigas,* the giant humming bird, is nine inches long, while the smallest scarcely exceed a bumblebee in size.

Although the parrots evidently originated in the Australasian region, where they are one of the predominent elements of the avifauna, South America is credited with having some of the most advanced genera. The Neotropical macaws, *Ara,* are the most showy and gaudily colored of the entire parrot tribe. Rivaling the macaws in coloration is the quetzal, *Pharomacrus,* the national symbol of Guatemala. The brilliantly colored toucan, *Ramphastos,* is another typical Neotropical form. The Neotropical chatterers include the umbrella bird, *Cephalopterus;* the companero, *Chasmorhyncus;* and the cock of the rock, *Rupicola.* Closely related to the chatterers are the manakins, Pipridae, and the plant cutters.

**Reptiles.** Outstanding among the reptiles of South America are the crocodiles, *Crocodilus,* of Central and South America. The caymans, *Caiman,* close relatives of the alligator, are numerous in the rivers of the tropical regions.

The turtles are represented by members of the following families: Chelydridae, Dermatemyidae, Emydidae, and Testudinidae. The trionychid turtles, which are well represented in Holarctica, Ethiopia, and Australasia, are entirely absent from the Neotropical region. Lizards in the Neotropical region include amphisbaenids, anguids, and iguanids. Among the latter are the basilisk, *Basiliscus,* and the common iguana, *Iguana.* Snakes characteristic of South America include the bushmaster, *Lachesis mutus;* the fer-de-lance, *Bothrops atrox;* and the largest of all snakes, the anaconda, *Eunectes murinus.*

**Amphibians.** The amphibian fauna of South America is quite small, with only a few families represented. Except for three Amblystomas in Mexico, the plethodontid genus, *Oedipus,* includes all of the thirty or more Neotropical urodeles. Two genera of aglossal frogs, *Pipa* and *Protopipa,* inhabit the Amazonian and northern parts of South America. Their closest relatives, *Xenopus,* are found in Africa. *Eleutherodactylus* and *Leptodactylus* are typical of the bufonids in the Neotropics. Toads of the family Brachycephalidae are confined to South America. The tree frogs are typically New World forms and are widespread in South America, being

represented by the marsupial frogs, Hemiphractinae, and such genera as *Hyla, Gastrotheca,* and *Phyllomedusa.*

**Fishes.** South America is among the richest of the zoogeographic regions in the abundant variety of fresh-water fishes, ranging from the minute characins to the giant osteoglossid, *Arapaima.* Closely related to the African lungfish is the South American form, *Lepidosiren.* The largest portion of the fish fauna is composed of fishes of the order Ostariophysi. There are eleven families of catfishes. The most widely distributed family of the order is the Characinidae, many specimens of which are found in the aquaria of North American fish fanciers. The family includes both carnivorous and herbivorous forms and is represented by such genera as the cannibal fish *Serrasalmo; Curimatus;* and the fresh-water flying fish, *Gasteropelecus.* Closely related to the characins and probably derived from them are the electric eels, Gymnotidae, which are exclusively Neotropical in distribution. The oviparous cyprinodonts range southward from North America to Argentina. Another highly characteristic group of South American fishes is that of the numerous cichlids.

From the point of view of zoogeography, the Neotropical fishes are of great interest. The characins, cichlids, and nandids are shared with the Ethiopian region; the cichlids are shared with the Oriental region; and the lungfishes are shared with the Ethiopian and Australasian regions.

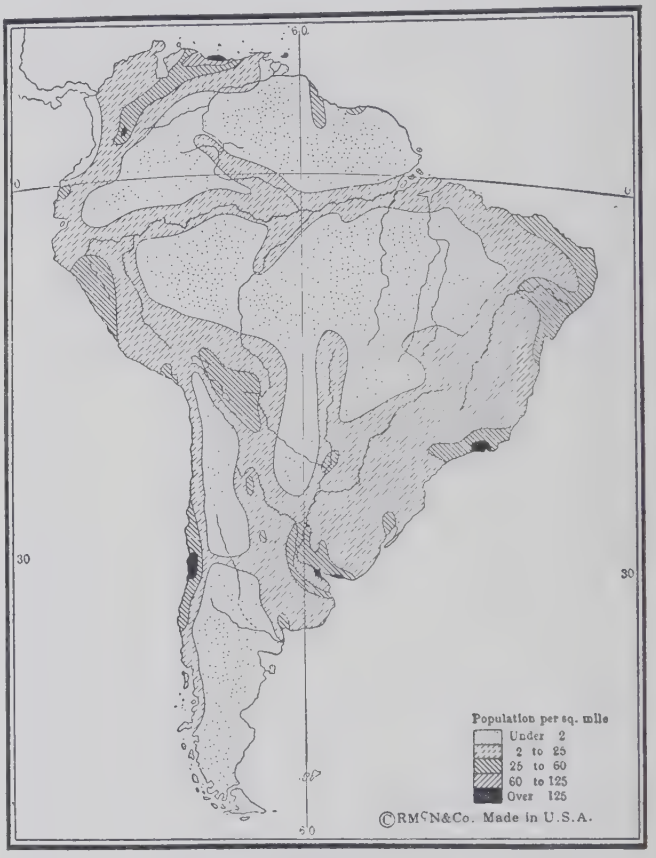
G. M. C.

## POPULATION

**Over-all Statistics.** The population of continental South America is approximately 103,373,000. According to estimates made between 1945 and 1947, the countries of South America have the following populations: Brazil, 50,700,000; Argentina, 16,104,929; Colombia, 10,544,670; Peru, 7,991,777; Chile, 5,389,554; Venezuela, 4,299,638; Bolivia, 3,854,100; Ecuador, 3,241,311; Uruguay, 2,202,936; Paraguay, 1,182,877; and the Guianas, 614,040. The totals represent an arbitrary computation of the Indian population of certain remote regions.

**Distribution.** The greatest part of the population of South America is found along the margins of the continent, with extensive interior areas of sparse population. In a broad zone along the Atlantic from the state of Rio Grande do Norte in Brazil to the humid Pampas of Argentina are located the three cities of the continent which have more than a million population, Rio de Janeiro, São Paulo, and Buenos Aires, as well as eleven of the other seventeen cities of the continent which have populations of over a quarter million. In western South America the greatest concentrations of population are in the high basins and valleys of the Colombian and Ecuadorian Andes, in the scattered coastal oases and Andean valleys of Peru, on the Bolivian Altiplano, and in the Central Valley of Chile. Even within these areas of population concentration, the pattern is one cluster separated by scantily settled territory, with only limited contact possible between the individual settled areas. The Antioquia region around Medellín, Colombia, the Central Valley of Chile, and the three southern states of Brazil are the only areas of concentrated population which show a marked expansion of their frontiers. In other areas pioneer settlements are remote from older settled areas and in many of them the settlers are new European immigrants. The vast virtually uninhabited regions of the continent—the Amazon Basin, western interior Brazil (the *Sertão*), the Gran Chaco, the eastern border valleys of the Andes, and Patagonia—have prompted much speculation on the possibilities of settlement by people from the overpopulated areas of the world. Even in the parts of these regions with the best climate and soils, however, isolation and the physical difficulties of transportation are significant limiting factors.

**Racial Groups.** The predominant racial composition of the population differs notably from one region to another. The three main elements are the Indian, the original inhabitant of the continent, the European, whether descended from the early Spanish and Portuguese colonial group or a more recent immigrant, and the Negro, originally imported as a




*POPULATION DENSITY*

laborer. Race mixture has gone on with little restriction or taboo, so that a very large proportion of South Americans are of mixed ancestry. The mestizo, the mixture of Indian and European, is the most commonly found racial type. In the Andean highlands of Ecuador, Peru, and Bolivia the dominant element of the population consists of Indians of the Quechua and Aymará linguistic groups. The Guiana Highlands, the upper Amazon Basin, and the more isolated parts of the Brazilian Highlands are occupied by widely scattered groups of more primitive Indians. During the nineteenth and twentieth centuries new immigrants from a number of European countries came to the previously sparsely settled southern and southeastern parts of South America. The considerable population of São Paulo, the three southern states of Brazil, southern Uruguay, and the humid Pampas of Argentina is largely of recent European origin: Italians, Spaniards, Portuguese, Germans, Poles, and lesser numbers of many other European nationalities. In Brazil, Negroes and mulattoes are numerous, particularly along the coast between Recife and Salvador. Negroes are dominant in the Pacific and Caribbean coastal regions of Colombia.

**Language.** The official language of Brazil is Portuguese and of the other republics, Spanish. In many areas Indian

languages are more common than the official language. In Peru, for instance, 50 per cent of the population speaks either Quechua or Aymará, and of these many do not speak any Spanish. P. E. J.

**SOUTH AMERICAN INDIANS.** *See* INDIAN TRIBES, SOUTH AMERICAN.

**SOUTHAMPTON,** one of Great Britain's leading seaports, a municipal, county, and parliamentary borough, located in Hampshire, in southern England, about 70 mi. southwest of London. The port lies at the head of the estuary Southampton Water, on a peninsula bordered on one side by the Test River and on the other by the Itchen River. The sheltered port, which is accessible to the largest ships afloat, has practically silt-free deep waters. In addition, the harbor is favored by double tides. Southampton is an important cargo port, but it is most famous as Britain's leading overseas passenger terminal with passenger ships from the world over docking at its piers. The discovery of Roman relics in the area attests to Roman settlements on the site, and there is evidence that the community has always been a port. The Norman kings moored their ships in the roads, and during the Middle Ages the port was controlled by the guild merchants, who carried on extensive trade with the Continent and the Orient. It was from Southampton that the Pilgrims in 1620 embarked on the *Mayflower* for the New World. Southampton, which had received its first town charter from Henry II in 1154 and had begun to send two members to Parliament in 1295, was granted a city charter by Charles I in 1640. Its real significance as a port dates from 1803 with the construction of a pier which became the foundation of the modern dock installations. The opening of the railroad to London in 1840 added impetus to the port's development, and by 1892 the docks covered more than 500 acres, an area which was to be subsequently trebled by the reclamation of tidal reaches and extensive dredging. The King George V Dock, which was the world's largest graving dock when it was opened in 1933, has a length of 1,200 ft., a width of 135 ft., and a depth of 50½ ft. During World War II the city was subjected to severe bombing raids, and approximately half of the city's buildings and many of the historic landmarks were either damaged or destroyed. In addition to shipbuilding and shipping, the city's chief industries include the manufacture of airplanes; the British Spitfire planes were first built at Southampton. The Royal Air Force maintains a seaplane base on an island in the channel, and there is a commercial airfield near the city. There is a large oil refinery in the suburb of Fawley and a small university, chartered in 1952, in the city itself. Southampton returns two members to Parliament. Pop. 1954, 175,500.

S. D. M.

**SOUTHAMPTON,** a village in southeastern New York, part of the township of the same name, situated 83 mi. east of New York City, on a narrow land strip, on the south shore of Long Island, between Peconic Bay and the Atlantic Ocean, facing the sea. The surrounding agricultural area is renowned for its potatoes. Founded in 1640, Southampton was incorporated as a village in 1894. For about two hundred years it was famous for its whaling activities, in which the Indians participated, and it was one of the chief trading ports of the Colonies. The village is famous as a fashionable summer resort and contains many estates. The old Hollyhocks House, built in 1662, and the Parrish Memorial Art Museum are features of the village. Near by is the Shinnecock Indian Reservation. Pop. 1950, 4,042.

**SOUTH AUSTRALIA,** a state in south central Australia with an area of 380,070 sq. mi., or 12.8 per cent of the total area of Australia. It is bounded on the north by Northern Territory, on the northeastern corner by Queensland, on the east by New South Wales and Victoria, on the south by the Indian Ocean, and on the west by Western Australia.

**Geographical Features.** *Topography.* Most of the state is under 2,000 ft. in elevation and relatively flat, with low tablelands in the northwest and shallow depressions such as Lake Eyre in the northeast. Lake Torrens and Lake Gairdner are the largest of several extensive bodies of water in the southeast. The only river of importance is the Murray in the extreme southeastern corner of the state, but artesian water underlies much of eastern South Australia. Not all of the state, however, is characterized by low plains or depressions with no outlet to the sea. In the northwest on the border with Northern Territory rise the Musgrave Ranges, highest point of which is Mount Woodroffe (4,970 ft.), and in the east the rugged Flinders Range dominates the surrounding lowlands. South Australia shares with Western Australia the Great Victoria Desert and Nullarbor Plain.

*Climate.* The northern half of the state is arid to semiarid with only 5 to 10 in. of rain a year, but the southern half, semiarid in the north, changes to humid in the southeast, where the average rainfall is over 50 in. annually at Mount Gambier, a town at the southeastern tip of the state. Erratic throughout the state, precipitation is least reliable in the north. While the northern rains come with the invasions of summer monsoons, those in the south are caused by cyclonic storms and fall in winter. Winter temperatures are moderate throughout, but summer temperatures are high nearly everywhere except on the southeastern coast.

*Forests and Soil.* Natural vegetation includes fairly dense eucalypt forests in the southeast, mallee or dwarf eucalypts along the Murray River and westward along the coast, open forests and park lands with grass and trees near Adelaide, and throughout most of the northern two thirds of the state desert and semidesert grasses, shrubs, and trees. There is little commercial timber. While there are some excellent soils in the vicinity of Adelaide and in patches along the Murray River, large areas have soils that are too stony, sandy, heavy, salty, or too poorly supplied with mineral nutrients or organic matter to be suitable for agriculture.

**Population.** The population of South Australia in 1947 was 646,216, with densities greater in the agricultural south, and much of the north either unoccupied or very thinly populated. Adelaide, with 382,604 inhabitants, or more than one-half the population of the state, is the capital and largest city. Port Adelaide (33,404) is the only other city over 7,000.

**Government.** *Administration.* The executive power of the state is vested in a governor, appointed by the British Crown, who is assisted by the Executive Council of 6 members. The legislative branch, Parliament, is divided into the Legislative Council of 20 members, half of whom are elected every three years, and the House of Assembly of 39 members, who serve three-year terms. The governor has no power to dissolve the Legislative Council.

*Political Parties.* In the elections of March 1950 there was little change in party representation in the House of Assembly, the Liberal Country League and the Independents gaining one seat each at the expense of the Labor Party. Totals were: Liberal Country League, 23; Labor, 12; and Independents, 4.

*Finance.* Revenue for 1948 totaled £18,843,000 and expenditures £19,156,000; the public debt was £118,852,000.

As in the other Australian states, the Commonwealth has been responsible since 1929 for state debts, contributing toward interest on the debt and the sinking fund set up for its redemption.

**Economic Resources and Activities.** Owing primarily to low rainfall, the occupied areas in the northern part of the state are suitable only for the light grazing of cattle and merino sheep, while the south coastal region and Murray River settlements have a more diversified economy based on agriculture, dairying, mining, and manufacturing. Almost any type of mediterranean or temperate fruit, grain, and vegetable can be grown in the better watered areas of the south and southeast. Dairying has developed in the vicinity of Adelaide and still more recently in the southeast. Dual purpose sheep, raised for both meat and wool, are pastured extensively in the wheat belt, and pig raising, poultry farming, and apiculture are important activities in favored localities. Mineral resources include low-grade bituminous coal, iron, pottery clays, salt, gypsum, copper, and lead, of which only iron has been mined extensively in the last decade. Manufacturing is concentrated in a few centers such as Adelaide, Port Adelaide, and Port Pirie.

**Social and Cultural Activities.** *Education.* Education in South Australia is compulsory and free up to 14 years of age. Primary, secondary, and technical public schools totaled 805 in 1946 and had 81,912 enrollees; besides several denominational schools, there were 155 private schools in 1947 with 21,936 students. In addition to technical and trades schools at higher levels, there are the University of Adelaide and a teachers' college.

*Social Services.* Benefits for disability, and old age and war pensions are paid by the Commonwealth, but there are several state provisions covering maternity, childhood endowment, widows, and the unemployed and sick.

R. G. B.

**History.** The early history of South Australia is closely associated with Edward Gibbon Wakefield's colonization theory, the essence of which was that land in a colony should be sold to settlers at a reasonable minimum price and the proceeds used to bring more colonists. Wakefield believed his system would produce a proper balance among land, labor, and capital within a colony.

The South Australian Land Company was founded in 1831 but could not persuade the Colonial Office to transfer the necessary land to a private company. Two years later the South Australia Association took up the problem and induced the imperial government to agree to the founding of a colony, which, however, was to be under governmental auspices. Land was to be sold for at least 12 shillings per acre and transportation of criminals was not to be permitted. Since the imperial government refused to provide financial aid a new South Australia Company was formed in 1834 by George Fife Angas for investment in the future of the colony.

Colonists arrived in 1836 and a settlement was made at what is now Adelaide. Because of the heavy expenditures required at first, the governor, George Gawler, drew drafts on the imperial government for public construction. Those who bought land sold it at a profit instead of putting it to productive use. The governor spent more than $1,000,000 (£291,000) above the revenue of the colony and a boom resulted. The imperial government decided not to honor the excess bills on the treasury and sent Captain George Grey to replace Gawler. After an investigation, the imperial Parliament in 1842 made South Australia a crown colony.

Grey, arriving in 1841, attacked with vigor the task of saving the new colony. His policy was one of forcing it to live within its means, and he persuaded the imperial government to honor the excess bills and thus enable the colony to make a new financial beginning. By 1842 he had put South Australia on its feet.

A parliamentary act of 1850 made possible the adoption of new forms of government in the Australian colonies. South Australia took advantage of the law and in 1853 prepared a new constitution which went into effect in 1856. The new government was bicameral, with the lower house being elected on a franchise, and the members of the existing Legislative Council being given life tenures in the new upper house carrying the same name. The system of responsible government was put into operation by common consent.

The absence of gold fields and the decision not to permit the transportation of convicts to the colony made a better-balanced economic life than that in New South Wales and Victoria. The gold rush in Victoria, moreover, acted as a stimulant to the production of grains and meat to supply the mining communities. By 1870 South Australian wheat had supplanted American wheat in the Australian market. Farmers in the colony gave considerable attention to harvesting equipment and soil fertilization. Successful breeding from the original flocks of merino sheep for arid conditions enabled pastoralists to compete with the concurrent development of agriculture.

South Australia for a time co-operated with the federal council set up in 1885. The Constitutional Convention of 1897 met in Adelaide, and South Australian voters gave a heavy majority to the proposed constitution in 1898 and 1899. In January 1901 South Australia joined the other Australian colonies in uniting to form the Commonwealth. In 1911 Northern Territory, formerly part of South Australia, was detached and made a separate territory. R. V. S.

**SOUTH BEND,** a city of central northern Indiana, the county seat of St. Joseph Co., situated on the St. Joseph River, 80 mi. southeast of Chicago. The name of the city is derived from its location on the south bend of the St. Joseph River. It was founded in 1831 by two rival fur traders, Alexis Coquillard and Lathrop Taylor, who became fast friends and worked together to lay out the town. South Bend was incorporated as a town in 1835 and as a city in 1865, and has the mayor-council form of government. Events of historical interest were the signing of important Indian treaties in 1679 and 1681 on the city's site. Historical sites of interest in the city and vicinity are the Council Oak, under which the Indian treaties were concluded; the Pierre Navarre Cabin, home of an early fur trader in the area; and the Northern Indiana Historical Museum. South Bend is the seat of the University of Notre Dame and St. Mary's College. Transportation is provided by the Grand Trunk, the Chicago, South Shore and South Bend, the New York Central, the Pennsylvania, and the New Jersey, Indiana and Illinois railroads, and by the American, the United, and the Trans World air lines. Highly diversified industries include in their output automobiles and truck and bus chassis; a wide range of products for airplanes, automobiles, ships, and radios; farm equipment; varnish; precision lathes; malleable-steel ranges; and sewing machines. Pop. 1950, 115,911.

**SOUTH BEVELAND.** *See* BEVELAND, SOUTH.

**SOUTH BOSTON,** a town in south central Virginia, situated in Halifax Co., about 65 mi. southeast of Roanoke, on the Dan River, in an agricultural area where tobacco, corn, and wheat are leading crops. The town is an important

# SOUTH CAROLINA

## *Index to Physical Features and Points of Interest*

### TOPOGRAPHIC FEATURES

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Lemon, island . . . . . G 6
Morgan, island . . . . . G 6
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North, island . . . . . E 9
Palms, island . . . . . F 8
Phillips, island . . . . . G 6
Pinckney, island . . . . . G 6
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Cooper, river . . . . . E 8
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Dewees, inlet . . . . . F 8
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South, fork . . . . . E 8
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Fishing, creek . . . . . B 5
Fishing Creek, reservoir . . . . . B 6
Fripps, inlet . . . . . G 7
Frompton, inlet . . . . . G 2
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FINAL 1950 CENSUS

# SOUTH CAROLINA

Area . . . . . 31,055 sq. m.
Population . . . . 2,117,027

KEY TO MAP SYMBOLS

- State Capital
- County Seat
- Cities over 100,000
- Size of symbols and type indicates relative population.

CITIES AND TOWNS


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Alcolu, 797 . . . . . D 7
Allendale, 2,474 . . . . . F 5
Allsbrook, 75 . . . . . C10
Alvin, 300 . . . . . E 8
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Arcadia, 2,554 . . . . . B 4
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Aynor, 551 . . . . . D 9
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Barnwell, 2,005 . . . . . E 5
Barton, 60 . . . . . F 5
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Bath . . . . . D 4
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Blair Mills, 200 . . . . . B 2
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Blenheim, 153 . . . . . B 8
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Blythewood, 250 . . . . . C 6
Bonneau, 408 . . . . . E 8
Bordeaux, 150 . . . . . D 3
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Cherokee, 450 . . . . F 2, F 8
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Chesnee, 1,051 . . . . . A 4
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Chesterfield, 1,530 . . . . B 7
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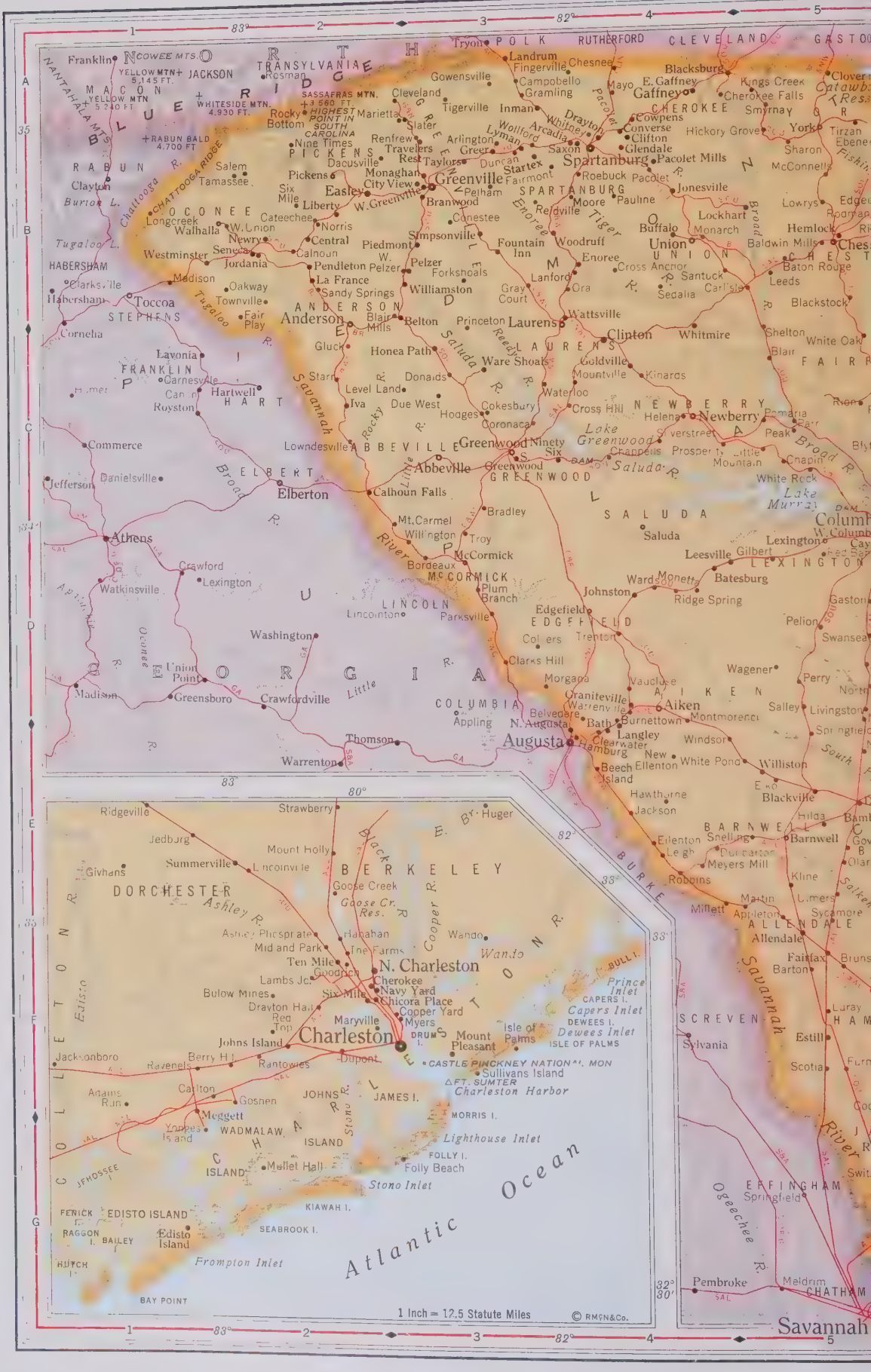
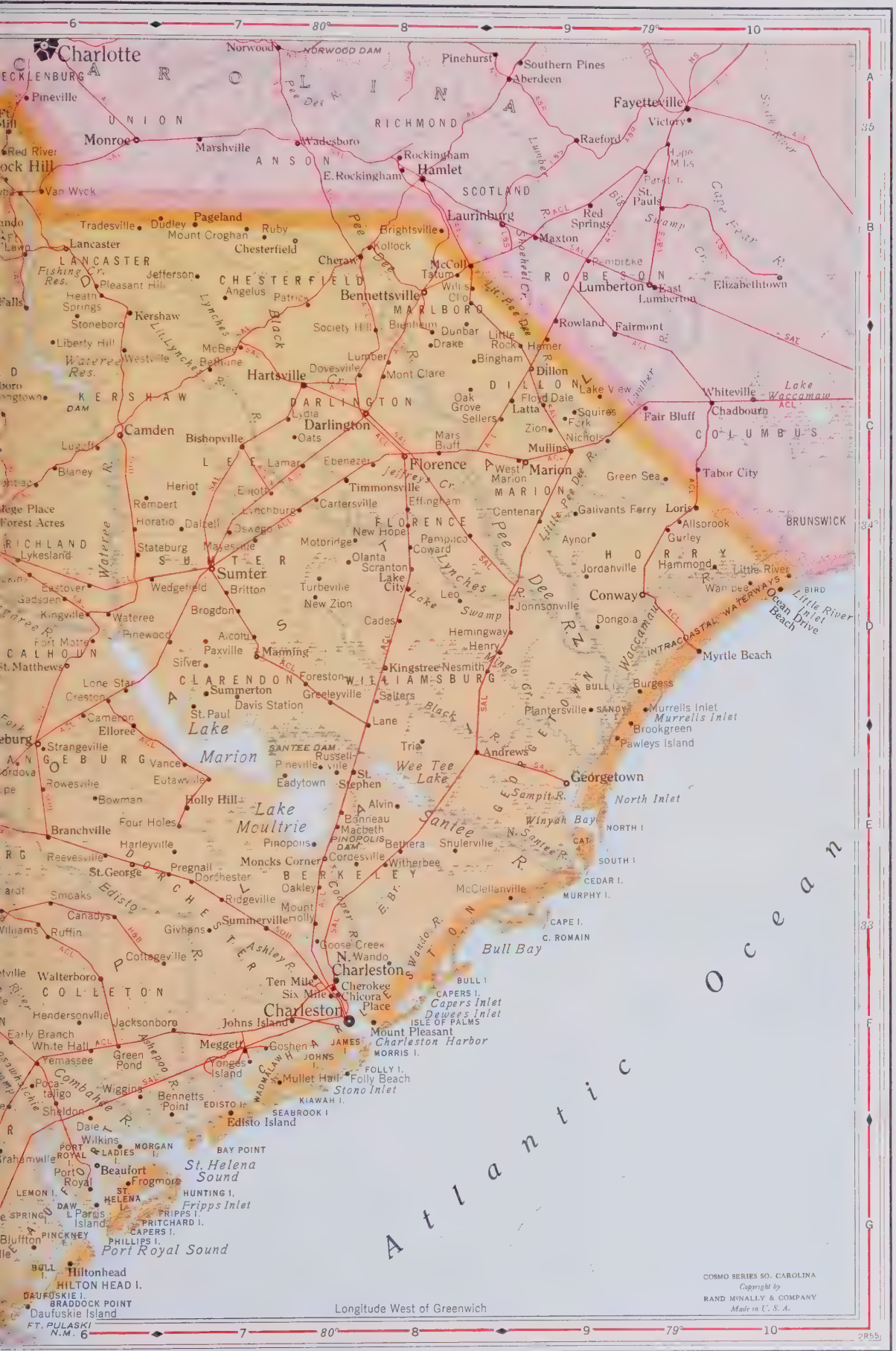
City View-Riverside-Woodside, 8,471 . . . B 2
Clarks Hill, 300 . . . . . D 3
Clearwater, 804 . . . . . E 4
Cleveland, 250 . . . . . A 2
Clifton, 1,707 . . . . . B 4
Clinton, 7,168 . . . . . C 4
Clio, 837 . . . . . B 8
Clover, 3,276 . . . . . A 5
Cokesbury, 117 . . . . . C 3
College Place, 1,187 . . C 5


LETTERS AND FIGURES IN RIGHT HAND COLUMN OF INDEX ARE THE LOCATION KEYS. THE CORRESPONDING LETTERS AND FIGURES APPEAR IN THE MAP BORDER BETWEEN LATITUDE AND LONGITUDE LINES WHICH FORM THE REFERENCE ZONES.

# SOUTH CAROLINA





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Converse, 1,200 . . . . . B 4
Conway, 6,073 . . . . . D 9
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Estill, 1,659 . . . . . F 5
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Floyd Dale, 150 . . . . . D 9
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New Zion, 100.....D 7
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St. George, 1,938.....E 6
St. Matthews, 2,351....D 6
St. Paul, 315.....D 7
St. Stephen, 1,341.....E 8
Salem, 250.....B 2
Salley, 407.....D 5
Salters, 100.....D 8
Saluda, 1,594.....D 4
Sandy Springs, 300....B 2
Santuck, 150.....B 4
Saxon, 3,088.....B 4
Scotia, 226.....F 5
Scranton, 602.....D 8
Seaside, 200.....B 4
Sellers, 530.....C 9
Seneca, 3,649.....B 2
Sharon, 365.....B 5
Sheldon, 500.....F 6
Shelton, 110.....C 5
Shulerville, 400.....E 8
Siver, 50.....D 7
Silverstreet, 201.....C 4
Simpsonville, 1,529....B 3
Six Mile.....F 2, F 8
Six Mile, 157.....B 2
Slater, 726.....A 3
Smoaks 130.....E 6
Smyrna, 105.....A 5
Snelling, 34.....E 5
Society Hill, 645.....B 8
South Greenwood, 3,712
C 3
Spartanburg, 36,795....B 4
Springfield, 782.....D 5
Squires, 200.....C 9
Starr, 282.....C 2
Startex (Tucapau),
1,638.....B 3
Stateburg, 200.....D 6
Stoneboro, 50.....B 6
Strangeville, 626.....E 6
Strawberry, 50.....E 2
Sullivans Island
(Moultrieville), 898...F 3
Summerton, 1,419.....D 7
Summerville, 3,312 E 2, E 7
Sumter, 20,185.....D 7
Swansea, 762.....D 5
Switzerland, 200.....G 5
Sycamore, 383.....E 5
Tamassee, 350.....B 1
Tatum, 119.....B 8
Taylors, 518.....B 3
Ten Mile.....F 2, F 7
The Farms, 100.....F 2
Tigerville, 105.....A 3
Tillman, 750.....G 5
Timmonsville, 2,001....C 8
Tirzah, 200.....B 5
Townville, 200.....B 2
Tradesville, 50.....B 6
Travellers Rest, 500.....B 4
Trenton, 296.....D 4
Troy, 250.....E 8
Troy, 242.....D 3
Tucapau, see Startex.
Turbeville, 271.....D 7
Ulmers, 139.....E 5
Union, 9,730.....B 4
Vance, 106.....E 7
Van Wyck, 250.....B 6
Varnville, 1,180.....F 5
Vaucluse, 507.....D 4
Wagener, 584.....D 5
Walhalla, 3,104.....B 1
Walterboro, 4,616.....F 6
Wampee, 250.....D10
Wando, 265.....E 8, F 3
Ware, 122.....D 4
Ware Shoals, 3,032.....C 3
Warrenville, 1,604.....D 4
Wateree, 50.....D 6
Waterloo, 162.....C 3
Wattsville 2,500.....B 4
Wedgefield, 500.....D 7
Wellford 721.....B 3
West Columbia, 4,373..D 5
West Greenville, 2,233
B 2
West Marion, 500.....C 9
Westminster, 2,219.....B 1
West Pelzer 578.....B 2
West Union, 429.....B 2
Westville, 200.....C 6
White Hall, 130.....F 6
White Oak, 125.....C 5
White Pond 150.....E 5
White Rock 141.....C 5
Whitmire, 3,006.....B 4
Whitney, 1,611.....B 4
Wiggins 200.....F 6
Wilkins, 500.....C 6
Williams, 254.....E 6
Williamston, 2,782....B 3
Willington, 452.....D 3
Willis 75.....B 8
Williston, 896.....E 5
Windsor, 151.....E 4
Winnsboro, 3,267.....C 5
Witherbee, 225.....E 8
Woodford, 179.....D 5
Woodruff, 3,831.....B 3
Yemassee, 712.....F 6
Yonges Island, 250..G 1, G 7
York, 4,181.....B 5
Zion, 216.....C 9


### COUNTIES


Abbeville, 22,456.....C 3
Aiken, 53,137.....D 4
Allenaale, 11,773.....E 5
Anderson, 90,664.....B 2
Bamberg, 17,533.....E 5
Barnwell, 17,266.....E 5
Beaufort, 26,993.....G 6
Berkeley, 30,251.....E 8
Calhoun, 14,753.....D 6
Charleston, 164,856....F 8
Cherokee, 34,992.....A 4
Chester, 32,597.....B 5
Chesterfield, 36,236....B 7
Clarendon, 32,215.....D 7
Colleton, 28,242.....F 6
Darlington, 50,016.....C 8
Dillon, 30,930.....C 9
Dorchester 22,601.....E 7
Edgefield, 16,591.....D 4
Fairfield, 21,780.....C 5
Florence, 79,710.....C 8
Georgetown, 31,762....D 9
Greenville, 168,152....B 3
Greenwood, 41,628....C 3
Hampton, 18,027.....F 5
Horry, 59,820.....D10
Jasper, 10,995.....G 5
Kershaw, 32,287.....C 6
Lancaster, 37,071.....B 6
Laurens, 46,974.....C 4
Lee, 23,173.....C 7
Lexington, 44,279.....D 5
McCormick, 9,577.....D 3
Marion, 33 1.....C 9
Marlboro, 31 766.....B 8
Newberry, 31,771.....C 4
Oconee, 39,050.....B 1
Orangeburg, 68,726....E 6
Pickens, 40,058.....B 2
Richland, 142,565.....D 6
Saluda, 15,924.....C 4
Spartanburg, 150,349...B 4
Sumter, 57,634.....D 7
Union, 31,334.....B 4
Williamsburg, 43,807...D 8
York, 71,596.....A 5

tobacco market. South Boston, incorporated as a town in 1884, has the council-manager type of government. Transportation is provided by the Southern and the Norfolk and Western railroads. The chief local products include cotton, rayon, flour, condensed milk, and foundry products. Pop. 1950, 6,057.

**SOUTHBRIDGE,** a residential town in south central Massachusetts, situated in Worcester Co., on the Quinebaug River, 17 mi. southwest of Worcester, in an agricultural area devoted largely to dairying. Founded in 1730, Southbridge was incorporated as a town in 1816. The local government is by town meeting. A large proportion of the population is composed of French-Canadians. The privately financed Wells Museum contains a collection of Spanish, Central European, and early United States relics. The New York, New Haven and Hartford Railroad affords transportation. Local manufactures include worsteds, cutlery, and optical goods. Flood damage of over $20,000,000 occurred in August 1955. Pop. 1950, 16,748.

**SOUTH CAROLINA,** popularly known as the Palmetto State, one of the South Atlantic states of the United States. It is bounded on the north and northeast by North Carolina, on the southeast by the Atlantic Ocean, and on the southwest and west by Georgia, from which South Carolina is separated by the Savannah, Tugaloo, and Chattooga rivers. The area of the state is 31,055 sq. mi., of which about 750 sq. mi. are inland water. South Carolina, the smallest of the southern states, ranks thirty-ninth in size among the states of the Union.

South Carolina was one of the original thirteen colonies and was the eighth state to ratify the federal constitution; it entered the Union on May 23, 1788. The state motto is *Animis Opibusque Parati* ("Prepared in Mind and Resources"); another motto, *Dum Spiro Spero* ("While I Breathe, I Hope") also appears on the seal. The state tree is the palmetto; the state flower is the yellow jasmine; the state bird is the Carolina wren; and the state song is *Carolina,* music by Anne Curtis Burgess and words by Henry Timrod. South Carolina has forty-six counties; the state capital is Columbia.

## PHYSICAL FEATURES

**Topography.** South Carolina is made up of parts of three physiographic provinces which extend northwest to southeast across the state. The northwest belt, about 500 sq. mi. in area, lies within the Blue Ridge province. In this region are found the highest elevations as well as the greatest irregularity. Besides Sassafras Mountain (3,560 ft.), the highest elevation in the state, the Blue Ridge contains such peaks as Pinnacle Mountain (3,413 ft.); Hogback Mountain (3,226 ft.); Caesar's Head (3,218 ft.), and Table Rock (3,157 ft.).

The central belt of the state, about 10,500 sq. mi. in area, is a part of the Piedmont Upland province. The Piedmont has a rolling topography, its elevations ranging from 200 to 400 ft. along the southeastern border to 1,200 to 1,500 ft. at the base of the Blue Ridge.

The southeastern or coastal belt, about 20,000 sq. mi. in area, forming a part of the Atlantic Coastal Plain province, is low in elevation and comparatively level. The northern part of the coastline forms a great arc, made up for the most part of a fine sand beach broken by a few inlets such as Little River, Murrells, and North inlets. From Winyah Bay to the Savannah River the coastline is broken by bays, rivers, and inlets, many of which connect separate irregular areas of low elevation, such as the Sea Islands, from the mainland. The sea margins of the islands usually have firm sandy beaches. The larger bays and inlets, like those at Charleston, Georgetown, Port Royal, and Beaufort, form good harbors.

The materials which underlie the Blue Ridge and Piedmont provinces consist mainly of granites, gneisses, and schists, while the deposits of the Coastal Plain are mostly unconsolidated sands, clays, and marls. At the junction of the more resistant rocks of the Piedmont and the less resistant rocks of the Coastal Plain the streams have a series of falls or rapids, making the Fall Line, which marks the boundary between the two regions.

*THE SEAL OF THE STATE OF SOUTH CAROLINA*

*Hydrography.* Three river systems, namely, the Santee, the Pee Dee, and the Savannah, drain most of the state. These rivers and several smaller streams, including the Black, the Edisto, the Combahee, and the Coosawhatchie, which rise within the state, flow southeastward to the coast. In the upper and central parts of the state the streams flow swiftly through well-defined valleys and are important sources of water power, but below the Fall Line the streams become sluggish, flow through wide valleys, and are usually bordered by extensive swamps. The three largest lakes in the state—Lake Murray (about 53,760 acres in area), Lake Marion (about 96,000 acres), and Lake Moultrie (about 64,000 acres)—are artificial bodies of water constructed in connection with hydroelectric and navigation projects.

**Climate.** South Carolina has a humid subtropical type of climate, characterized by long summers and mild winters and by abundant rainfall distributed throughout the year. The mean annual temperature for the state as a whole is 63.0° F., varying between 45.5° in January and 79.8° in July. At Charleston, situated on the coast, the mean annual, January, and July temperatures are 67.1°, 49.9°, and 81.4° respectively, and at Greenville, in the upper Piedmont, they are 61.3°, 40.3°, and 76.9°. The maximum temperature on record in the state is 111° F. and the minimum is —13°. The average annual precipitation is 47.7 in., ranging from 61.3 in. in Oconee County to 45.5 in. in Barnwell County. The average frost-free season for the state is 229 days, ranging from 276 days at Charleston to 190 days at Caesar's Head. Snow is uncommon in the coastal section, and elsewhere it rarely remains on the ground long except in the Blue Ridge.

**Soil.** The parent materials from which the soils of South Carolina have been derived are crystalline rocks in the Piedmont and Blue Ridge, and sands, clay, and impure limestone in the Coastal Plain. Along the larger rivers there are belts of alluvial soils. Except for the limited areas of gray-brown podzolic soils of the Blue Ridge, the soils of South Carolina all belong to the red and yellow soils so extensively developed in the southeastern part of the United States.

EWING GALLOWAY

*Live oak avenue on a South Carolina plantation*

**Forests and Parks.** South Carolina has parts of three general forest regions. The Blue Ridge and Piedmont come within the southern hardwood forest, the upland areas of the Coastal Plain are in the southeastern pine forest, and along the river bottoms and in the swamps of the coastal region occur the river bottom forests. On the upper slopes of the Blue Ridge are found birch, beech, maple, and hemlock, the major part of the mountain area supporting a chestnut, oak, and yellow poplar forest interspersed with many other types of trees. The Piedmont forest cover is largely a mixture of short-leaf pine, oak, and hickory. The Coastal Plain, except for the river bottoms and swamps, has predominantly a long-leaf pine forest. In the river bottoms and swamps are found cypress, tupelo, gum, bay, water ash, willow, cottonwood, and water oak.

There are two national forests in the state, totaling in area 581,050 acres: the Sumter National Forest, located in the Piedmont and Blue Ridge sections, and the Francis Marion National Forest, located in Berkeley and Charleston counties. There are six state or county forests aggregating 148,618 acres.

**Flora.** Along the coast occur several species of palmettos and yuccas, the evergreen Carolina laurel cherry, the groundsel bush, the American olive, and other subtropical foliage. The river bottoms and swamps contain, in addition to the trees already described, such plants as honeysuckle, sweet bay, pitcher plants, Venus' flytrap, smilax, gallberry, loblolly bay, and the yellow jasmine, the state flower. In the higher sandy plains there are dogwood, trailing arbutus, sparkleberry, Spanish moss, and the pyxie, or flowering moss. The mountainous areas of the state are noted for their colorful displays of rhododendrons, azaleas, and kalmias.

*A limestone quarry in operation in Cherokee County, near the city of Gaffney, South Carolina*

AL SHARP FROM LILLER, NEAL & BATTLE

**Fauna.** The white-tailed deer is still common in the coastal areas, but the black bear and the wildcat are seldom encountered even in the upper wooded regions. Smaller mammals native to the state include oppossums, raccoons, otter, skunks, muskrats, shrews, red and gray foxes and squirrels, cottontail rabbits, marsh rabbits, rats, mice, moles, bats, weasels, minks, and woodchucks. Among the reptiles are six species of lizards, the alligator, and forty-three species of snakes, including four poisonous species: the water moccasin, the copperhead, the rattlesnake, and the coral snake. There are many species of turtles, salamanders, frogs, and toads. More than twenty varieties of edible fresh-water fish include the catfish, carp, wide-mouthed bass, crappie, bream, and warmouth. Among marine fish of commercial importance are the sturgeon, shad, menhaden, founder, sea bass, blue fish, hickory shad, sea trout, red drum, black drum, grunt, and king whiting. Oysters, crabs, clams, and shrimp are also taken in marketable quantities. The teeming bird life of the South Carolina coast includes the snake bird, the brown pelican, and innumerable ducks and shore birds, among the latter willets, terns, Wilson plovers, and oystercatchers. Egrets and herons abound in the swamps, and bobwhites, wild turkeys, doves, woodcocks, and Wilson snipe are plentiful in the plains and wooded areas. Among commoner birds of the interior are catbirds, orioles, mockingbirds, thrushes, sparrows, wrens, swallows, and vireos.

## ECONOMIC RESOURCES AND ACTIVITIES

**Minerals and Mining.** South Carolina has no appreciable coal or iron ore deposits; mining is a minor industry largely confined to mineral products such as kaolin clay, sand, crushed stone, vermiculite, and kayonite. No gold or silver is being mined in the state, nor is there any mining for precious stones. According to the 1950-1951 report of the state Department of Labor there are 33 mining operations in South Carolina, most of them sand pits and quarries; the value of the mineral output in 1951 was $12,145,944.

**Agriculture.** Despite the constant growth of manufacturing, farming remains the chief occupation of the inhabitants of the state. On Apr. 1, 1950, the 139,364 farms in the state comprised 11,878,793 acres, or 61.2 per cent of the total area, of which 5,385,990 acres were cropland, 2,190,638 acres, pasture land, and 5,561,854 acres, woodland. The farms averaged 85.2 acres and had a value of $69.06 per acre. The average value of land and buildings was $5,648 per farm. Total cash receipts in the state from crops in 1951 amounted to $396,442,000.

LEADING SOUTH CAROLINA CROPS

(1951)

| | *Acreage Harvested (1,000)* | *Production (1,000)* |
|---|---|---|
| Cotton lint | 1,045 | 871 bales |
| Cottonseed | 1,045 | 355 tons |
| Tobacco | 132 | 175,560 lb. |
| Corn | 1,316 | 26,320 bu. |
| Oats | 576 | 16,128 bu. |
| Wheat | 175 | 3,500 bu. |
| Peaches | ... | 4,330 bu. |
| Hay | 456 | 371 tons |
| Sweet potatoes | 28 | 2,380 bu. |

Truck farming is of importance, a great variety of vegetables being raised in commercial quantities.

*Animal Industry.* As of April 1950, there were 389,560

cattle on South Carolina farms, valued at $33,000,503; 598,076 hogs, valued at $7,843,118; 4,250 sheep, valued at $38,844; 23,331 horses, valued at $2,429,650; 146,522 mules, valued at $24,979,653; 3,550,985 chickens, valued at $3,748,304; and 56,871 turkeys, valued at $227,937. The total value of livestock, dairy products, and poultry and poultry products sold in 1949 was $40,018,391.

**Fisheries.** Ten hatcheries operated by the state game department produce bream, bass, and trout. Shrimping is the major fishing industry; raw shrimp caught in 1949 totaled 24,000,000 lb., valued at $5,000,000. Oysters, shad, menhaden, crabs, and clams are the most important species of marine life taken in commercial quantities in South Carolina waters.

**Water Power.** Installed generating capacity of electric plants in South Carolina on June 30, 1951 totaled 1,096,840 kw. of which 674,695 kw. comes from hydroelectric plants. The major hydroelectric plants are located at Pinopolis in Berkeley County and at Dreher Shoals in Lexington County.

**Manufacturing.** In 1951 there were 1,795 manufacturing establishments in the state, employing 193,396 persons who were paid a total of $455,941,569 in wages. The capital invested in all industries totaled $867,285,102, and the total value of all manufactured products was $2,230,507,920. Chief industrial areas are in Greenville, Spartanburg, Anderson, Columbia, Charleston, Lancaster, and Rock Hill.

LEADING SOUTH CAROLINA INDUSTRIES
(1951)

| | *Avg. No. of Persons Employed* | *Wages Earned in Year ($1,000)* | *Value Added by Manufacture ($1,000)* |
|---|---|---|---|
| Textiles | 130,838 | $346,102 | $1,608,985 |
| Paper and pulp | 3,811 | 12,562 | 110,638 |
| Clothing | 12,290 | 20,257 | 68,360 |
| Wood products and furniture | 8,973 | 16,204 | 63,868 |
| Fertilizer | 2,260 | 3,651 | 36,363 |

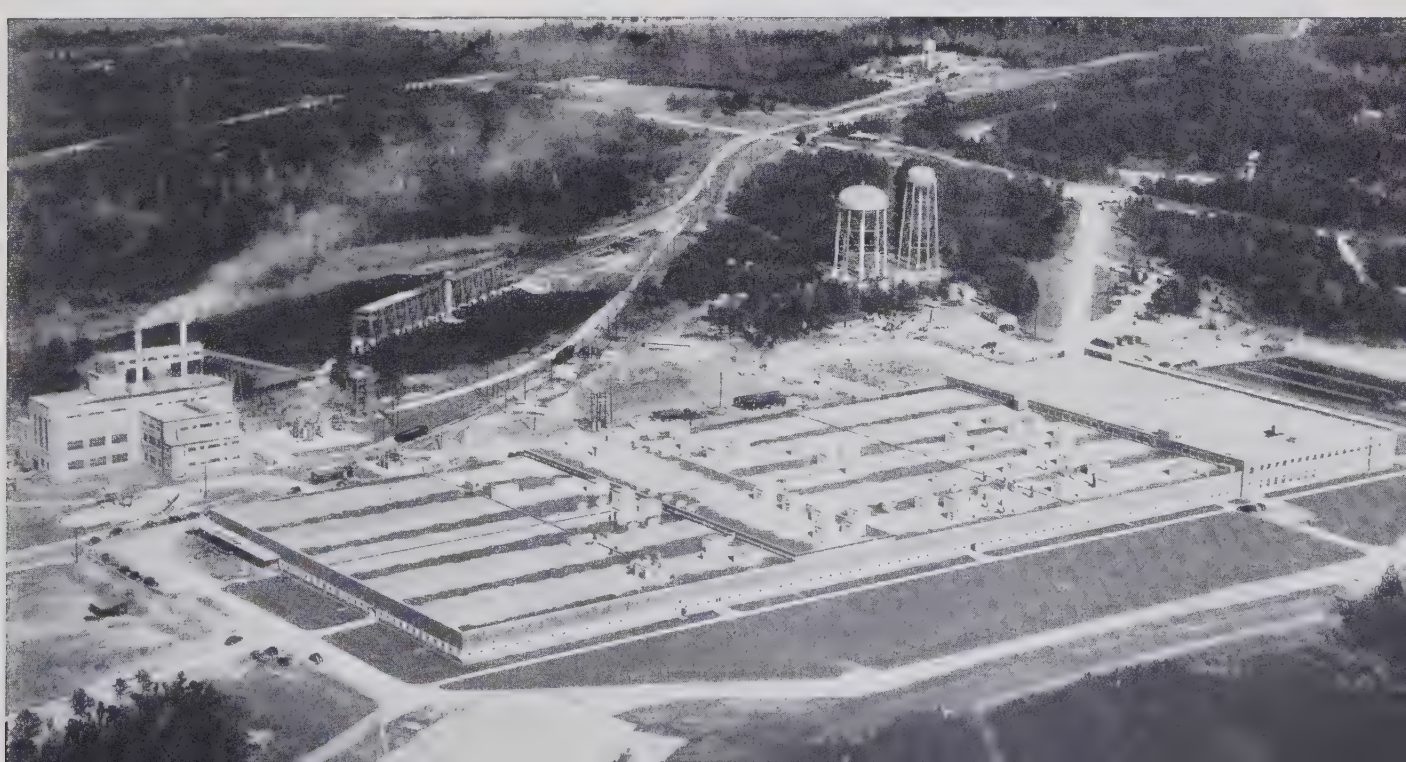
Other manufactures include chemicals and allied products, and stone, clay, and glass products.

**Transportation.** The first railroad operated by steam in the United States was the Charleston and Hamburg, chartered in 1827. By Jan. 1, 1830, this line had six miles of road ready for the "Best Friend," the first practical locomotive built in America. As of Dec. 31, 1950, there were 3,372 mi. of single or first main track of railway in the state. The Southern, the Atlantic Coast Line, the Seaboard Air Line, and the Charleston and Western Carolina are the main rail lines serving the state. In 1952 there were 49,330 mi. of highways in South Carolina, of which 23,138 mi. were in the state highway system; there were 8,889 mi. of primary road, and 14,249 mi. of secondary road. Of the total road mileage, 3,008 mi. have high-type pavement and 14,450 mi. have bituminous surface; the remaining 21,872 mi. have earth or soil-type surface. During the license year 1951-1952 a total of 649,742 motor vehicles were registered, of which 510,105 were passenger cars and taxis, 127,077 were trucks, 1,886 were commercial buses, and 3,366 were school buses. In 1952 there were 16 commercial and 37 mu-

CHARLES PHELPS CUSHING

*Farmer planting tobacco, by scattering the seeds through a screen, on a small plantation near Bennettsville, South Carolina. The long white cloth spread over the newly sown field protects the seeds from frost at night. In the background is a tobacco storage barn typical of the region.*

*BLEACHING PLANT AT A LARGE COTTON MILL IN SOUTH CAROLINA*



FAIRCHILD AERIAL SURVEYS—COLUMBIA RESEARCH, PLANNING & DEVELOPMENT BOARD

*AIR VIEW OF COLUMBIA, SOUTH CAROLINA'S CAPITAL CITY, WITH AN INSET SHOWING THE STATE CAPITOL*

nicipal airports plus some 25 or 30 private airstrips in the state. Delta, Southern, Eastern, and National air lines operate regularly scheduled routes within the state. The lower portions of the Savannah, the Edisto, the Santee-Cooper, and the Waccamaw rivers are used as navigable streams to a limited extent. The Intercoastal Waterway extends along the coast from the North Carolina line to the Savannah River. Charleston led all South Atlantic seaports in waterborne commerce during 1951 with port traffic totaling 4,614,909 tons; it led also in commerce to foreign countries and was only slightly exceeded by Savannah in imports.

**Communications.** In 1951 South Carolina had approximately 250,000 telephones in operation and 443,000 radio sets in 409,000 homes. There were 43 radio broadcasting stations in operation in 1952, and, although the state had no television stations, several are under construction for operation early in 1953. The state has 95 newspapers and 29 periodicals published in 89 towns. Sixteen of the newspapers are published daily (nine evening and six morning), two are tri-weekly, six are semi-weekly, and 71 are weekly papers. The Charlestown *News & Courier* and the *Post,* the Columbia *State,* and the Spartanburg *Herald & Journal* are among the leading newspapers of the state.

## GOVERNMENT AND POLITICS

**Constitution.** South Carolina is governed under a constitution established in 1895. An amendment to the constitution may be proposed in either house of the legislature, and if approved by two-thirds it must be submitted to the people at the next election held to choose members of the House of Representatives; then, if approved by a majority of those voting upon it and subsequently by a majority vote in each house of the General Assembly chosen at that election, the amendment becomes a part of the constitution. The constitution may be revised by a convention called by a two-thirds vote in each house and ratified by a majority of those voting for Representatives at the next election.

**Government Structure.** The chief executive is the governor, elected for a term of four years. The governor is ineligible to succeed himself. Other executive officers are the lieutenant governor, secretary of state, comptroller general, superintendent of education, commissioner of agriculture, adjutant general, treasurer, attorney general, and insurance commissioner.

The legislative body of South Carolina, known as the General Assembly, consists of a Senate, composed of one member from each of the forty-six counties, and a House of Representatives with one hundred twenty-four members from the counties in proportion to population. The Senators are elected for four years and the Representatives for two. The legislature meets annually at the state capitol in Columbia.

Judicial power is vested in a Supreme Court, made up of five judges elected by the legislature for terms of ten years, in two Circuit Courts, which comprise a court of common pleas, and in a Court of General Sessions.

**Finance and Banking.** General revenue and borrowings of the state of South Carolina, according to the *Compendium of State Government Finance in 1951,* published by the United States Department of Commerce, totaled $195,164,000 in that year, the general borrowings amounting to $27,550,000. The general revenue, totaling $167,614,000, included $103,790,000 in taxes and $33,673,000 in aid from other governments. The state tax revenue of $103,790,000 included $66,126,000 in sales, use, and gross receipts, $9,-

249,000 from license and privilege, $12,016,000 from individual income, $13,552,000 from corporation income, $1,512,000 from property, and $546,000 from death and gift sources. The sales, use, and gross receipts taxes, totaling $66,126,000 included $32,068,000 from motor fuels, $15,399,000 from alcoholic beverages, $8,097,000 from tobacco products, $2,799,000 from insurance companies, $3,136,000 from public utilities, $4,223,000 from soft drinks, and $404,000 from admissions and amusements. The license and privilege tax total, amounting to $9,249,000 included $5,381,000 from motor vehicles and operators, $539,000 from corporations in general, $757,000 from alcoholic beverages, $481,000 from hunting and fishing, $186,000 from chain stores, $215,000 from amusements, and $1,690,000 from occupations and miscellaneous sources.

General expenditure, according to the same source, totaled $166,612,000 in 1951 and included $7,133,000 for debt retirement, $49,382,000 for operation, $29,796,000 for capital outlay, $16,968,000 for assistance and subsidies, $2,225,000 for interest, and $8,492,000 for insurance benefits and payments. General expenditure for operation, capital outlay, and aid paid to local governments, totaling $159,479,000, included $36,977,000 for highways, $10,291,000 for health and hospitals, $56,064,000 for public education, and $16,899,000 for public welfare. The debt outstanding at the end of the fiscal year of 1951 was $119,143,000.

As of June 30, 1952, there were 102 state banks, 16 branches, one Military Facility, and 20 depositories having assets of $305,331,743 and deposits of $280,620,294, and 41 building and loan associations having assets of $50,269,080. On the same date 25 national banks with 39 branches had deposits of $490,472,000 and resources of $522,808,000.

## SOCIAL AND CULTURAL ACTIVITIES

**Education.** The first school in South Carolina was established in Charleston in 1701; it was run by John Douglas. Ten years later a free school was opened there for indigent children. While relatively little was done toward the advancement of public education until the next century, by 1826 thirty-two academies had been founded. The present free school system had its beginning in 1868. It is under the direction of an elected superintendent of education with the assistance of a board of education appointed by the governor. Separate schools are maintained for Negroes. Compulsory education laws require children from 6 to 14 years, or 16 years if unemployed, to attend school nine months annually.

During the school year 1951-1952 there were 3,279 public schools enrolling 512,199 pupils and employing 17,479 classroom teachers. In the elementary schools there were 386,142 pupils and 12,226 teachers; in the high schools, 126,057 pupils and 5,253 teachers. In addition to the public schools there were 27 private and denominational schools having 5,335 pupils and 252 teachers. The department of education works closely with the department of public welfare in vocational rehabilitation work and also maintains some special vocational schools. The value of school property was $120,068,668 in the 1951-1952 school year. During the same period $41,509,063 was paid in salaries of classroom teachers, the average salary of elementary teachers being $2,197 and that of high school teachers, $2,789. The 1951 General Assembly created a State Educational Finance Commission which has under way extensive reorganization of the school system, including full equalization of white and Negro schools. The funds for revitalizing the school system are largely derived from a three per cent retail sales tax which went into effect July 1, 1951.

The institutions of higher education maintained by the state are the University of South Carolina, at Columbia; Clemson Agricultural College, at Clemson; Winthrop College (The South Carolina College for Women), at Rock Hill; the State Colored Normal, Industrial, Agricultural and Mechanical College of South Carolina, at Orangeburg; and The Citadel (The Military College of South Carolina), at Charleston. Private institutions of higher learning include the College of Charleston, at Charleston; Erskine College, at Due West; Furman University, at Greenville; Newberry College, at Newberry; Presbyterian College, at Clinton; Wofford College, for men, at Spartanburg; and, for women, Coker College, at Hartsville, Columbia College at Columbia, Converse College, at Spartanburg, and Limestone College, at Gaffney. Claflin University, at Orangeburg, and Benedict College and Allen University, both at Columbia, are for Negroes.

**Social Measures.** The counties generally have some provision for care of the poor, but the State Department of Public Welfare provides old-age assistance and general assistance as well as aid to the blind, to dependent children, and to persons permanently and totally disabled. As of June 1951 there were 83,699 individuals on the relief rolls, receiving an average of $26.75 per month. Of the total, 42,870 received an average of $25.10 per month in old-age assistance; 1,606 needy blind persons received an average of $27.46; 19,254 dependent children received an average of $13.44; 3,714 individuals received an average of $20.75 in general assistance; and 2,319 persons totally and permanently disabled received an average of $32.15 per month. Total funds expended by the State Department of Public Welfare for the year ending June 30, 1951, amounted to $17,971,340. During the fiscal year 1951 the State Employment Security Commission had a total of 96,592 initial claims and made benefit payments to the amount of $6,572,907. During 1950 the monthly average of insured employment totaled $318,727, and wages reported to the Commission amounted to $748,000,000. The unemployment trust fund account totaled $53,500,297 on June 30, 1951.

AL SHARP FROM LILLER NEAL & BATTLE

*Fort Hill, home of John C. Calhoun, American statesman, at Clemson, South Carolina*

There is an industrial school for boys at Florence and one for girls near Columbia, and a reformatory for Negro boys near Columbia. At Clinton there is a state training school for mental defectives. A Confederate home, the state hospital, and the state penitentiary are at Columbia. The state tuber-

EWING GALLOWAY

*St. Philip's, Charleston, built in 1835-1838 from plans by Joseph Hyde, is the third church building to be erected by the first Anglican parish organized south of Virginia. Its lofty, octagonal tower, designed by Edward Brickell White, is one of the city's most famous landmarks.*

culosis sanatorium is at State Park, near Columbia. The Catawba Indian Reservation, comprising 652 acres, is located about 9 mi. east of Rock Hill. J. J. P.

**Cultural Activities.** Public libraries in the state are, almost without exception, county or regional libraries which now serve all but nine of the state's 46 counties. Forty bookmobiles carry books and library materials into the rural areas. The Charleston Library Society Library, organized in 1748, is the third of its kind established in the country. It contains many exceedingly rare volumes and an extremely valuable file of pre-Revolutionary newspapers dating as far back as 1732. The largest art collection in the state is that of the Gibbes Art Gallery in Charleston. The Columbia Museum of Art conducts an active program of contemporary and traditional art exhibits. The Charleston Museum, founded in 1773, is the oldest in the United States. It is devoted almost entirely to South Carolina culture. An open-air museum at Brookgreen Gardens, situated about 20 mi. north by road from Georgetown, exhibits one of the most notable collections of American bronze and marble statuary in the country. The leading musical event of its kind in the state is the Columbia Music Festival. Nonprofessional symphony orchestras perform periodically at Charleston, Greenville, and Due West, and the South Carolina Federation of Music Clubs has sponsored various musical projects and has endowed many scholarships. The ballads, folk songs, and Gullah chants for which South Carolina is famous have for many years been collected by the Southeastern Folklore Society. E. P. W.

## POPULATION

**General Statistics.** South Carolina had a population of 2,117,027 in the 1950 United States Census, an increase of 217,223, or 11.4 per cent over 1940. The average population per square mile in 1950 was 69.9 persons as compared with the national figures of 49.9. In 1950, 36.7 per cent of the population was classified as urban. The state ranks twenty-seventh in population and contains 1.41 per cent of the nation's total population. In 1950 the most populous of the state's forty-six counties was Greenville, which includes the city of Greenville, with a total of 168,152 persons. Charleston County, including the city of Charleston, was second with 164,856; Spartanburg County was third with 150,349, and Richland County, containing the capital of the state, Columbia, was fourth, with 142,565 persons. The largest cities in 1950 were Columbia, 86,914; Charleston, 70,174; Greenville, 58,161; and Spartanburg, 36,795. These are the only cities with a population over 25,000. Seven others have populations of over 10,000.

**Racial and Religious Groups.** According to the Census of 1950, 61.4 per cent of the population of South Carolina belonged to the white race, 38.8 per cent to the Negro race, and a total of 1,545 persons to other races. The foreign-born white population in 1950 included 907 from England and Wales, 816 from Germany, and 812 from Greece. In 1936 South Carolina had 4,263 churches with 710,163 members. In terms of numbers the three leading denominations were, in order, Baptist, Methodist, and Presbyterian.

**Occupational Groups.** In 1950 there were in the state 1,421,466 persons over 14 years of age; of the 798,177 persons in the labor force, 755,378 were employed. Manufacturing, with 36 per cent, and agriculture with 16.4 per cent of the employed, constituted the largest occupational groups.

## FAMOUS SITES AND PLACES

Charleston, founded with the early English settlement of the state, is filled with points of historic interest. For 120 years it was the capital of the province, and the city contains many buildings dating back to Colonial times, among them being several churches, many homes, the old powder magazine, the Dock Street Theater (the first wholly for drama in America), the museum, and the library. Columbia, established as the capital in 1786, has among its many historic features the State House, the University of South Carolina (third state university in the United States), and the First Baptist Church (meeting place of the Secession Convention).

South Carolina has a number of public and private gardens famous for their constructive planning and their flowers, especially azaleas and camellias. Among the better known are Brookgreen, near Georgetown; Swan Lake, near Sumter; Edisto, in Orangeburg; and Magnolia, Middleton Place, Cypress, and Mateeba, in the Charleston area. The southern part of the state contains a number of ante-bellum plantations which retain much of their former character.

There are nine state parks developed in co-operation with the National Park Service and six in co-operation with the United States Forest Service. These are widely distributed from the mountains to the seacoast and offer a wide variety of recreational opportunities. The National Park Service has established three sites of historic importance, namely, Pinckney National Monument in Charleston harbor, Cowpens National Battlefield Site in Cherokee County, and the Kings Mountain National Military Park in York County.

## HISTORY

**Exploration and Settlement.** The first Europeans to

reach South Carolina are believed to have been Spaniards. In 1521 an expedition consisting of two ships, the one commanded by Pedro de Quexos and the other by Francisco Gordillo, landed at the mouth of Winyah Bay seeking Indian slaves. In 1526 the Spanish established a settlement at Winyah Bay, but it was abandoned in a few months; a Spanish settlement at Parris Island in 1566 was maintained for several years. Hernando de Soto on his march to the Mississippi apparently passed through the region. The territory was claimed by Spain, although this claim was not fully recognized by the French or by the English. The French established a short-lived settlement at Port Royal in 1562. In 1663 Charles II granted the territory from sea to sea, between parallels 31° and 36°, to eight noblemen, later extending the grant to 29° and 36° 31′. William Sayle was appointed the first governor of the first English settlement, consisting of 148 people, including three Negro slaves, founded at Albemarle Point on the west bank of the Ashley River. In 1680 the center of settlement was removed to the peninsula between the Ashley and Cooper rivers, the present site of Charleston. Attractive terms were offered to settlers, encouraging them to come from England, France, the Barbados, and other colonies. By 1680 the settlement had 1,000 to 1,200 people; by 1700 its growth had reached nearly 16,000.

LOUIS TAGER FROM EWING GALLOWAY

*Monument to the defenders of Fort Sumter, object of an attack by Confederate forces on April 12-13, 1861, in the first engagement of the Civil War, stands on the Battery at Charleston, South Carolina.*

The Fundamental Constitutions, devised by Anthony Ashley Cooper, Earl of Shaftsbury, one of the Lord Proprietors, and John Locke, the English philosopher then serving as his secretary, were rejected by the colony, which in 1693 secured the right of initiating legislation. Disputes over the collection of quit-rents were bitter. The Church of England was made the established religion in 1706. North and South Carolina were separated in 1710, and the Proprietary control was overthrown in 1719 with the result that King George I sent Sir Francis Nicholson to South Carolina as Royal Governor, in 1721. Royal government did not check the rising tide of democracy; the popular assembly continued to outweigh both the governor and the council.

**Eighteenth Century.** A commerce in rice and indigo steadily expanded during the eighteenth century, but the prosperity of the colony at first largely depended on the Indian trade, in which the Carolinians daringly took the initiative, penetrating the wilderness, taking trade from the Spanish in Florida and alarming the French in Louisiana. Charleston, center of the Indian trade, became a cultural and commercial metropolis rivaling Philadelphia, New York, and Boston, the only cities exceeding it in population in 1775. Columbia succeeded Charleston as the capital in 1790.

The colony figured in Revolutionary agitation, voted troops as early as June 1775, forced the Governor to flee in September, and established a state government six months later. However, numerous Loyalists and the presence of British troops in 1780-1782 caused the state to suffer severely. Differences between the frontier regions and the wealthier coastal section did not prevent ratification of the Federal Constitution on May 23, 1788, but were reflected in the adoption of a new state constitution in 1790 which made the legislature practically supreme. In 1808 a revision of the constitution was made dividing representation equally between population and wealth; this revision remained in effect until 1868.

**Nineteenth Century.** Westward extension of the cotton plantation system overwhelmed early opposition to slavery interests. South Carolina, first as an opponent of protectionism in tariff and then as a rabid champion of slavery, took the lead in secession; its troops opened the Civil War by firing on Fort Sumter on Apr. 12, 1861. The state, which put 62,838 troops in the field, suffered heavily from the ravages of war, especially from Gen. William T. Sherman's march to the sea in 1865. Columbia was destroyed by fire.

The Reconstruction Era was particularly unfortunate in South Carolina. The election of Daniel H. Chamberlain, of Massachusetts, to the office of governor in 1874 aroused hopes of improved administration under the Radical Party then in power, but in 1876 when Gen. Wade Hampton, Confederate hero of the war and Democratic candidate, was elected governor, Chamberlain refused to vacate his office, on the ground that Hampton had been elected by questionable methods. The result was that two state governments, in bitter opposition, prevailed until the following year. Withdrawal of Federal troops from the state led to Chamberlain's relinquishment of office, to victory for Hampton's forces, and to disfranchisement of the Negroes. In 1890 acute distress among the farmers of the state, especially in the Piedmont region, led to the election of their candidate, Benjamin R. Tillman, who carried out a number of democratic reforms, including the establishment of agricultural and vocational education in the state. However, Tillman also established a state dispensary for the control of liquor which was ineffectively handled and resulted in widespread corruption.

**Twentieth Century.** State liquor dispensaries were abolished in 1907, but the control of liquor was to remain a campaign issue for many years; in 1933 South Carolina was one of the two states to vote for the retention of prohibition. During World War I the state contributed about 62,000 men to the armed forces, of whom 2,085 died in service.

Marked industrial development and, beginning with the administrations of Richard I. Manning (1915-1919), sound social progress have characterized the history of the state generally since the turn of the century. Notable work in the conservation of natural resources, begun in 1930, has been carried out under Federal auspices. In 1937 a child-labor law was passed prohibiting children under sixteen years of age from working in mines, factories, and textile establishments; and in 1947 a Federal court order, confirmed by the United States Supreme Court in 1948, established the right of Negroes to vote in primaries, annulled a discriminating

voter's oath, and ordered the admission of Negroes to all party committees and conventions. During World War II South Carolina contributed 136,000 men and 1,879 women to the army, and 51,482 men and 732 women to the navy.

J. J. P.

**SOUTH CAROLINA, STATE COLORED NORMAL, INDUSTRIAL, AGRICULTURAL AND MECHANICAL COLLEGE OF,** an accredited, coeducational, state-controlled college of arts and sciences for Negroes, occupying 450 acres in Orangeburg, S. C. Established in 1895, the college offered courses in agriculture, arts and science, and mechanic arts. The divisions of Home Economics, Agriculture, Arts and Sciences, and Mechanic Arts (later named Engineering and Industrial Education) were established in 1932; the Graduate Division in 1946; and the Law School in 1948. Degrees offered include the A.B. and the B.S. in liberal arts; the B.S. in agriculture, business administration, and engineering; the M.S.; the M.A.; and the LL.B. There is a large extension division.

Some scholarship aid is offered, but there is no loan fund. Dormitories and dining halls are provided for men and women. Sororities and fraternities are permitted, but members do not live in the houses. Opportunities for self-help enable students to earn part or all of their expenses. *For statistics see* COLLEGES AND UNIVERSITIES.

J. R. To.

**SOUTH CAROLINA, UNIVERSITY OF,** an accredited, coeducational, state-controlled institution occupying 46 acres in the city of Columbia, S. C. Chartered as South Carolina College in 1801, it was known as the University of South Carolina from 1866 to 1877. After a three-year period of inactivity, the college resumed operation in 1880 under the name of South Carolina College of Agriculture and Mechanics. The name reverted to the original form in 1882 and became the University of South Carolina in 1888. Again in 1891 the name was changed to South Carolina College. Finally in 1906 the present name was adopted. The many divisions of the university were founded as follows: College of Arts and Sciences, 1805; School of Pharmacy, 1865; School of Law, 1867; School of Education, 1882; Graduate School, 1906; School of Engineering, 1909; Summer School, 1914; Extension Division, 1915; School of Commerce (now the School of Business Administration), 1919; School of Journalism, 1923; and School of Social Work, 1934. The local chapter of Phi Beta Kappa was organized in 1926.

The degrees offered include the A.B. and the B.S. in liberal arts and in education; the A.B. in journalism; and the B.S. in business administration, pharmacy, and in civil, chemical, electrical, mechanical, and general engineering. Also offered are the LL.B.; the M.S.; the M.Ed.; the M.S.S.; the graduate degrees of civil, chemical, electrical, mechanical, and general engineering; the M.A.; and occasionally the Ph.D. Recent additions include a Department of Nursing, a Department of Homemaking, and a major in music.

Scholarships and graduate fellowships in varying amounts are offered and there is a loan fund available. Approximately half the students earn part of their expenses. Dormitories and dining halls are provided for men and women. Women from outside the city must live in the dormitories unless approval for other living arrangements is received from the dean of women. *For statistics see* COLLEGES AND UNIVERSITIES.

J. R. To.

**SOUTH CHARLESTON,** a residential town in western West Virginia, situated in Kanawha Co., on the Kanawha River, 2 mi. west of Charleston, of which it is a suburb. Its government is administered by a mayor and council. An interesting historic feature of the town is the Indian burial mound in Staunton Park, 175 ft. in circumference at the base and 30 ft. high. When opened by the Federal Government in 1883, it was found to contain many relics, including pottery fragments, stone weapons, and some dozen skeletons, one 7 ft. in height. Transportation is provided by the Chesapeake and Ohio Railroad and by the All American Aviation air line. The town is known for the manufacture of chemicals, its principal industry. Pop. 1950, 16,686.

**SOUTH CHINA SEA,** a large, tropical body of water off southeast Asia. It is partly enclosed by South China and Formosa on the north, the Philippine Islands on the east, Borneo on the south, and French Indochina and Malaya on the west. Formosa Strait connects the sea with the East China Sea, and there are two large gulfs: that of Siam, in the southwest, and that of Tonking, in the northwest. Numerous islands and reefs and frequent tropical storms of high intensity make parts of the sea hazardous for shipping, although around its periphery are to be found such fine, important harbors as Hong Kong and Macao, Manila, Brunei, Singapore, Saigon, and Haiphong.

J. E. F.

**SOUTH DAKOTA,** commonly called the Sunshine State, one of the north central states of the United States. Its name is derived from the Dakota or Sioux Indians who were the chief inhabitants of the region when the first white men appeared. Rectangular in shape and lying roughly between 96° and 104° 3′ W. long. and 43° and 46° N. lat., it is bounded on the north by North Dakota, on the east by Minnesota and Iowa, on the south by Nebraska, and on the west by Wyoming and Montana. It embraces an area of 77,047 sq. mi., of which 511 sq. mi. are water surface. It ranks fifteenth among the states in size, being slightly smaller than Nebraska and larger than the combined area of New England.

GREAT SEAL OF THE STATE OF SOUTH DAKOTA

South Dakota and North Dakota both entered the Union on Nov. 2, 1889, and are counted as the fortieth and thirty-ninth states to achieve statehood. The state motto is "Under God the People Rule"; the state flower is the pasque flower; the state bird is the ring-necked pheasant; the state song is *Hail, South Dakota.* There are 64 organized and three unorganized counties in the state; the capital is Pierre.

### PHYSICAL FEATURES

**Topography.** The state has three main physiographic sections: the Prairie Plains, the Great Plains, and the Black Hills. The Prairie Plains section is a continuation of the prairies of Iowa and Minnesota and comprises most of the area lying east of the Missouri River. Its elevation ranges

# SOUTH DAKOTA

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(Highest Point in South Dakota)
Highest Point in South Dakota, 7,240'....G 2
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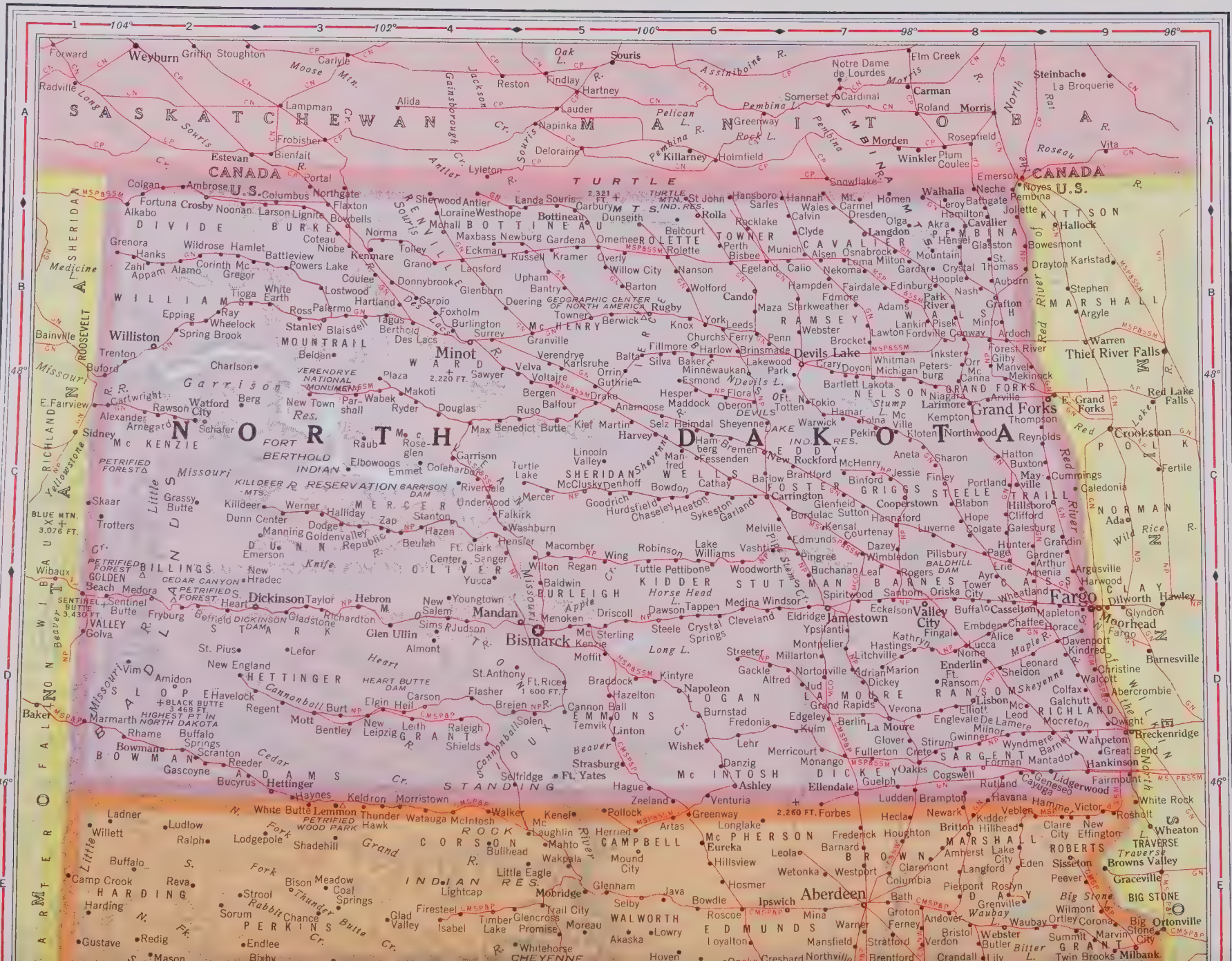
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NORTH DAKOTA
SASKATCHEWAN
MANITOBA
CANADA
U.S.
Bismarck
Minot
Williston
Dickinson
Mandan
Fargo
Grand Forks
Devils Lake
Jamestown
Valley City
Wahpeton
Moorhead
Thief River Falls
Aberdeen
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Turtle Mts.
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Baldhill Dam
Pembina Mts.
Pembina
Rock Lake
Lake Alice
Lake Darling
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Medicine L.
Oak L.
Pelican L.
Rat R.
Roseau R.
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Enderlin
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Wyndmere
Milnor
Oakes
Hankinson
Lidgerwood
Wahpeton
Breckenridge
Wheaton
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Graceville
Big Stone
Ortonville
Milbank
Sisseton
Webster
Watertown
Redfield
Huron
Mitchell
Yankton
Sioux Falls
Brookings
Madison
Pierre
Rapid City
Mobridge
Gettysburg
Aberdeen
Watertown
Sioux City
Omaha
Minneapolis
Fargo
Grand Forks
Winnipeg
Regina
Saskatoon
Brandon
Portage la Prairie
Dauphin
Swan River
Yorkton
Moose Jaw
Medicine Hat
Calgary
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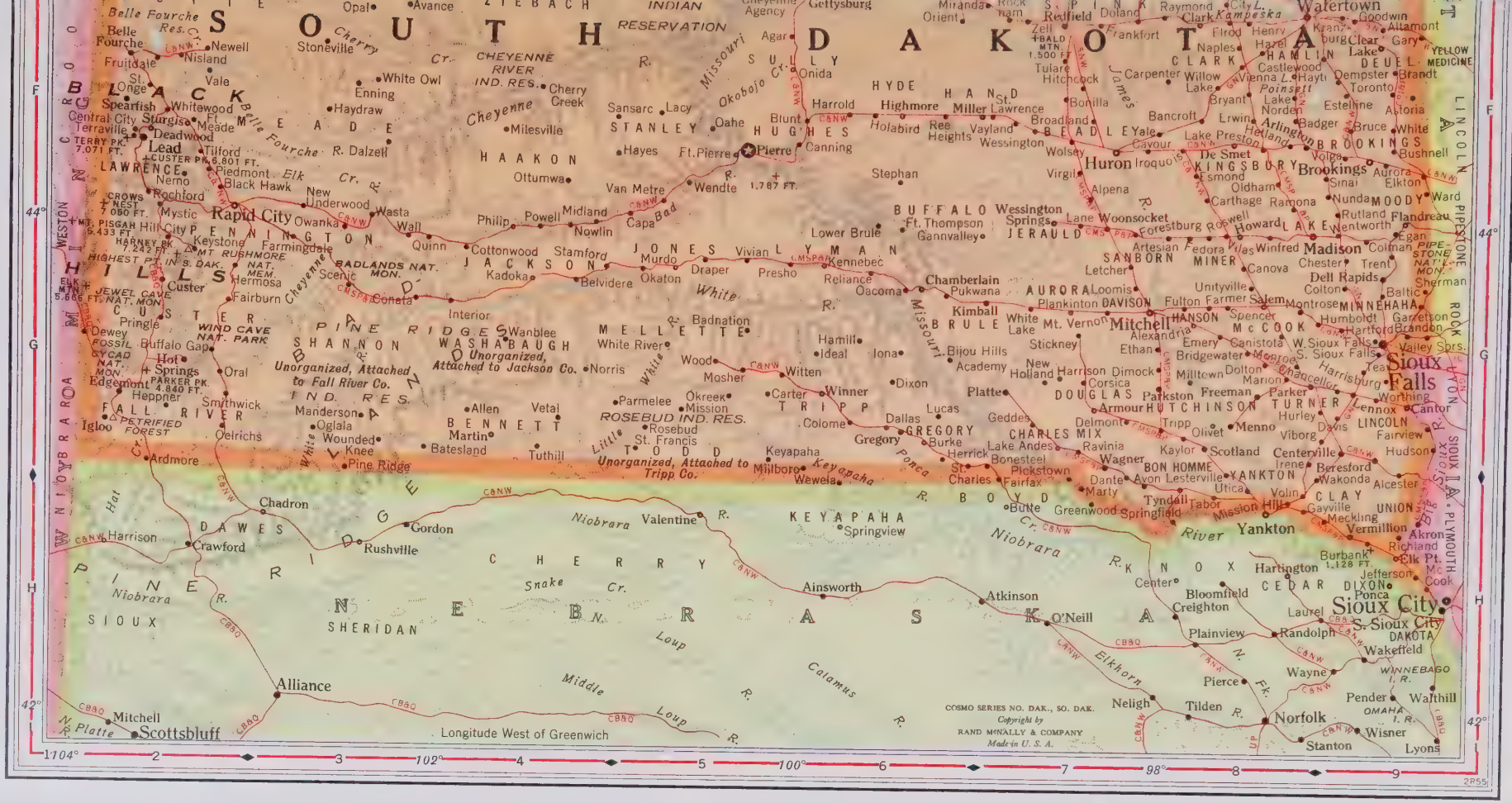
Edmonton
Lethbridge
Billings




LETTERS AND FIGURES IN RIGHT HAND COLUMN OF INDEX ARE THE LOCATION KEYS. THE CORRESPONDING LETTERS AND FIGURES APPEAR IN THE MAP BORDER BETWEEN LATITUDE AND LONGITUDE LINES WHICH FORM THE REFERENCE ZONES.

FINAL 1950 CENSUS

## SOUTH DAKOTA

Area.....77,047 sq. m.
Population.....652,740

### KEY TO MAP SYMBOLS

- State Capital
- County Seat
- Size of symbols and type indicates relative population.

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## NORTH DAKOTA

**Area** . . . . . **70,665 sq. m.**
**Population** . . . . . **619,636**

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Dunn, 7,212 . . . . . C 3
Eddy, 5,372 . . . . . C 7
Emmons, 9,715 . . . . . D 5
Foster, 5,337 . . . . . C 7
Golden Valley, 3,499 . . . D 2
Grand Forks, 39,443 . . . C 8
Grant, 7,114 . . . . . D 4
Griggs, 5,460 . . . . . C 7
Hettinger, 7,100 . . . . . D 3
Kidder, 6,168 . . . . . C 6
La Moure, 9,498 . . . . . D 7
Logan, 6,357 . . . . . D 6
McHenry, 12,556 . . . . . B 5
McIntosh, 7,590 . . . . . D 6
McKenzie, 6,849 . . . . . C 2
McLean, 18,824 . . . . . C 4
Mercer, 8,686 . . . . . C 4
Morton, 19,295 . . . . . D 4
Mountrail, 9,418 . . . . . B 3
Nelson, 8,090 . . . . . C 7
Oliver, 3,091 . . . . . C 4
Pembina, 13,990 . . . . . B 8
Pierce, 8,326 . . . . . B 5
Ramsey, 14,373 . . . . . B 7
Ransom, 8,876 . . . . . D 8
Renville, 5,405 . . . . . B 4
Richland, 19,865 . . . . . D 9
Rolette, 11,102 . . . . . B 6
Sargent, 7,616 . . . . . D 8
Sheridan, 5,253 . . . . . C 5
Sioux, 3,696 . . . . . D 5
Slope, 2,315 . . . . . D 2
Stark, 16,137 . . . . . D 3
Steele, 5,145 . . . . . C 8
Stutsman, 24,158 . . . . . C 7
Towner, 6,360 . . . . . B 6
Traill, 11,359 . . . . . C 8
Walsh, 18,859 . . . . . B 8
Ward, 34,782 . . . . . B 4
Wells, 10,417 . . . . . C 6
Williams, 16,442 . . . . . B 2

from 1,100 to 2,000 ft. Generally glaciated, it is differentiated by (1) the Dakota or James basin, a large shallow trough from 50 to 75 mi. wide and 250 mi. long; (2) the Coteau des Prairie, or eastern divide, which is a rough, broad, lake-dotted plateau some 60 or 70 mi. in width and standing from 500 to 700 ft. above the James River valley on the west and the Red, Minnesota, and Big Sioux valleys on the east; and (3) the Coteau du Missouri, or the Missouri divide, 25 to 30 mi. in width, lying from 200 to 700 ft. above the James basin and the gorge of the Missouri River and possessing the climatic and physical characteristics of the Great Plains region into which it merges.

The Great Plains, with an average elevation of 2,800 ft., present a varied topography including extensive, nearly level areas as well as wide stretches of hilly upland surmounted by lofty conical and flat-topped buttes and seamed by deep gorges. "Badland" formations are common features, usually forming the bluffs of river valleys or the sides of large buttes, the largest and most picturesque being the White River Badlands, which cover an area over 100 mi. long. The Black Hills are a mountainous area with an elevation of over 5,000 ft., elliptical in shape and about 100 mi. long and 50 mi. wide. Two thirds of the area lies in South Dakota, contiguous to Wyoming. Harney Peak, in the central part, has an elevation of 7,242 ft., the highest point in North America east of the Rocky Mountains.

The Missouri is the principal river, flowing through the middle of the state from north to south and draining most of the area. In the northeastern corner lies the continental watershed, the southern part draining through Big Stone Lake and the Minnesota River into the Mississippi basin, while the northern part drains through Lake Traverse and the Red River of the North into Hudson Bay. The tributaries of the Missouri in the eastern half of the state are the Big Sioux, the Vermillion, and the James, all flowing in a southerly direction. In the western part of the state the Grand, the Moreau, the Cheyenne, and the White follow the eastward slope toward the Missouri, cutting gorges and trenches in their course and contributing to the butte and canyon topography so characteristic of the Great Plains region in South Dakota.

Numerous lakes of glacial origin are found in the northeastern section, the so-called Lake Region of South Dakota. They vary from large lakes, several miles across, to small lakes that are shallow and hold water only during wet seasons. Since the 1930's, 1,185 artificial lakes have been constructed, most of them under the water conservation program fostered by local, state, and federal agencies.

**Climate.** The state has an invigorating climate with recorded extreme temperatures of 115° F. and —46° F. The mean annual temperature is 45° F. Average annual precipitation is 20 in. but ranges from 25 in. in the eastern section to 14 in. in the northwestern part. Normally, three fourths of the rainfall occurs during the growing season. The rainfall, however, varies greatly from year to year with corresponding effects on crop production. South Dakota has had several severe droughts in the past, notably in the periods 1886-1894, 1910-1911, and 1930-1936. The average growing season is 135 days but ranges from 105 in the western part to 145 days in the southeastern section. Contrary to popular belief, blizzards are not common but strike with great violence when they occur.

**Soil.** Most of eastern South Dakota has a clay-loam soil of glacial origin, similar to that found in Minnesota and Iowa. This soil is rich in humus and is dark colored to a considerable depth. The predominant soil type west of the Missouri River is Pierre clay or "gumbo," derived from the weathering of Pierre shale which outcrops widely. It does not absorb moisture readily, has a strong tendency to cake when dry, and becomes sticky when wet. Nevertheless, "gumbo" yields abundantly under favorable moisture conditions. Clay loams and sandy loams are also widespread in western South Dakota.

**Forests.** Wooded areas, occupying about 3 per cent of the total area of the state, are confined mostly to the Black Hills and lie for the greater part within the boundaries of the Black Hills National Forest, which covers 605,054 acres, and of the Harney National Forest, which has an area of 720,317 acres. Custer National Forest, in the northwest section of the state, has an area of 77,826 acres. The woods consist chiefly of yellow pine, white elm, spruce, red cedar, bur oak, cottonwood, box elder, and aspen.

**Flora.** Flowering plants in the northeast lake region include the pink wild rose, buttercup, primrose, pink bearded tongue, purple and yellow violets, blazing star, and, in the creeks, white lilies. Prominent among wild flowers of the central section of the state are the black-eyed Susan, wild orange geranium, prickly poppy, and Mariposa lily. From the Missouri River westward are found the gumbo lily, yucca, and a cactus bearing yellow flowers. In the Black Hills region the blue flag or iris is common, also the wood orchid, bluebell, yellow lady slipper, and larkspur.

**Fauna.** Coyotes were at one time so plentiful that the state was frequently referred to as the Coyote State. Buffalo, also once present in great numbers, have been reduced to small herds confined to Custer State Park and Wind Cave National Park. In the Black Hills elk and deer are not uncommon; smaller mammals found there include the bobcat, beaver,

*Farmer cultivating corn on a large farm at Centerville, South Dakota, operates a general-purpose tractor equipped with a two-row cultivator.*

EWING GALLOWAY

raccoon, porcupine, and several kinds of squirrels. The antelope, jack rabbit, and prairie dog are encountered west of the Missouri River; eastward, the badger, gopher, muskrat, skunk, weasel, and jack rabbit survive.

Twenty-four kinds of reptiles, including snakes, lizards, and turtles, are native to the state. The bull snake is the most common, the rattlesnake being rarely found east of the Missouri River, and the horned lizard is prevalent in many localities.

Approximately three hundred species of birds are found in the state. Waterfowl, plentiful in the lakes of the northeastern section, include ducks, geese, swans, pelicans, cranes, cormorants, herons, gulls, and the water ouzel. In the eastern part of the state are found the meadow lark, flicker, goldfinch, kingfisher, robin, swallow, brown thrush, humming bird, Chinese pheasant, prairie chicken, ring-necked pheasant, Hungarian partridge, and the red-winged and the yellow-headed blackbird. West of the Missouri grouse are still abundant, and the golden and the bald eagle are not uncommon. In the Black Hills are encountered the catbird, wood thrush, bluebird, rock wren, crossbill, woodpecker, and many species of warblers. The magpie, screech owl, great horned owl, water buzzard, and prairie chicken occur throughout the state.

There is excellent fishing for trout in the mountain creeks, and for pike, bass, and other game fish in the numerous lakes. Eight state fish hatcheries and rearing ponds are maintained.

A definite program for the conservation of wild life was inaugurated in 1907, when all wild birds were declared the property of the state; a game code was established in 1909. A State Game and Fish Commission, created in 1913, was changed to the Department of Game, Fish, and Parks in 1945. The Izaak Walton League, established in the state in 1925, has worked in close harmony with the department in sponsoring conservation legislation and in promoting conservation sentiment and practices.

## ECONOMIC RESOURCES AND ACTIVITIES

**Mining and Minerals.** Mineral production in South Dakota in 1950 totaled $26,870,174. Gold, the principal metal mined, contributed $19,879,860 to this total, most of it from the famous Homestake Mine, which was located in 1877 and has become the largest gold mine in the Western Hemisphere. South Dakota in 1950 ranked first among the states of the Union in the output of gold, producing 567,996 troy ounces, compared with the 457,551 troy ounces produced in Utah and 417,231 troy ounces produced in California in the same year. Materials used in building and in highway construction are mined and quarried in large volume, ranking next to gold in value. These materials include sand, gravel, an attractive mahogany granite, and Sioux quartzite, produced extensively in the eastern section of the state. In 1950 about 124,975 tons of bentonite were produced, the value of which was estimated at $1,766,522. Limestone is extensively quarried, and feldspar and lithium are produced in appreciable quantities, also iron ore, gypsum, and mica. Some lignite coal is mined, large deposits of which exist in the northwestern part of the state where they are relatively inaccessible to transportation. Manganese deposits of low-grade ore, found along the Missouri River west of Chamberlain, have been subjected to pilot mill tests but cannot be profitably exploited under present processing methods.

**Agriculture.** The state is primarily agricultural with 86 per cent of its surface area in farms, ranking ninth with respect to total area of first-grade land. The average size per farm in 1950 was 674 acres, and the average value per acre was $31.31. The value of the farms, including land and buildings, was $1,402,235,000. In 1944 there were 52,895 acres under irrigation, represented by 708 farms. Irrigation in 1952 was mostly confined to the Belle Fourche Reclamation Project in Butte County, inaugurated in 1908, and the Angostura Valley Project in Fall River County, put in operation in 1952.

A mixed farming pattern prevails in the eastern half of the state. The western section is chiefly devoted to stock raising, although grain crops are produced in many areas. Corn is the chief crop in the southeastern counties while spring wheat predominates in the northern part. In recent years blue grass seed has become an important cash crop for the prairies; production in 1951 amounted to 973,000 bu.

Leading South Dakota Crops
(1951)

| | *Acreage Harvested* (1,000) | *Production* (1,000) |
|---|---|---|
| Corn | 3,892 | 85,624 bu. |
| Wheat | 3,839 | 57,260 bu. |
| Hay | 4,748 | 4,517 tons |
| Oats | 3,145 | 116,363 bu. |
| Barley | 838 | 19,693 bu. |
| Flaxseed | 573 | 4,584 bu. |
| Rye | 512 | 6,656 bu. |
| Alfalfa seed | 99 | 50 bu. |
| Potatoes | 11 | 1,650 bu. |

Cash receipts from crops in South Dakota totaled $195,402,000 in 1951.

**Animal Industry.** Cash receipts from livestock and livestock products in South Dakota in 1951 totaled $600,607,000. Dairying and feeding of beef cattle are the forms of cattle raising in the eastern part of the state; range production under a modified ranching program prevails in the Great Plains area. In 1950 there were 27,000 livestock brands on record. The average ranch contains 1,464, acres; a few big cattle outfits, however, run their stock over as many as 30,000 acres. As of Jan. 1, 1952, there were 2,826,000 cattle in the state, valued at $562,374,000; 350,000 cows and heifers, valued at $95,900,000; 1,774,000 swine, valued at $67,589,000; 1,039,000 sheep, valued at $30,747,000; 127,000 horses and mules, valued at $4,461,000; and 9,077,000 chickens, valued at $11,800,000. In 1951, 350,000 turkeys were produced, representing a total value of $2,017,000.

**Manufacturing.** Industrial activities in the state consist primarily of processing farm products. In 1947 there were 494 manufacturing establishments furnishing employment to 10,265 persons who were paid $25,796,000 in salaries and wages. Of these employees 8,062 were production workers who received $19,193,000 in wages. The value added to products by manufacture in 1947 totaled $51,398,000.

Leading South Dakota Manufactures
(1947)

| | *Avg. No. of Persons Employed* | *Wages Earned in Year* ($1,000) | *Value Added by Manufacture* ($1,000) |
|---|---|---|---|
| Food and kindred products | 6,827 | 17,637 | 35,246 |
| Printing and publishing industries | 1,152 | 2,669 | 5,566 |
| Lumber and products except furniture | 994 | 2,160 | 3,506 |
| Machinery except electrical | 472 | 1,232 | 2,398 |

Other manufactures included stone, clay, and glass prod-

EWING GALLOWAY

*South Dakota highway winding through a strange region of ridges and clay mounds, from which rise grotesque formations capped with sandstone. This area borders on the White River in the southwestern part of the state.*

ucts, chemicals and allied products, and fabricated metal products.

**Transportation.** In 1952 there were 98,597 mi. of rural roads in the state, of which 3,566 mi. were improved paved roads and 2,630 mi. were of gravel surface. In 1951 there were 296,426 motor-vehicle registrations, of which 219,233 were automobiles and 75,402 commercial motor vehicles. In 1952 there were 3,960 mi. of steam railways in South Dakota, the chief systems being the Chicago and North Western Railway and the Chicago, Milwaukee, St. Paul and Pacific Railroad. As of April 1952, there were 75 airports in the state and about 150 private landing strips. Nine cities had airway service.

## GOVERNMENT AND POLITICS

**Constitution.** The constitution adopted in 1889 contains many provisions that are detailed in character. The amending process, consequently, has been freely resorted to. Over fifty amendments have been accepted by the voters, including one at the 1952 election.

**Government Structure.** In addition to the governor and lieutenant governor, six leading administrative officers are elected by the voters, as are also the members of the Public Utility Commission. The governor is elected to a two-year term and is not eligible for more than two successive nominations in the primary. The candidates for governor are chosen by a direct primary except when no candidate receives 35 per cent of the vote cast, in which case nomination is by party convention; all other elective officials are nominated by party convention, except the superintendent of public instruction and judges who are nominated and elected on a nonpolitical ballot.

The bicameral legislature is composed of 35 senators and 75 representatives, elected every two years. It convenes at Pierre, the capital, on the first Monday after the first Tuesday in January of odd-numbered years for a limited session of 60 days.

The judicial department, chosen by nonpolitical ballot, consists of five supreme court judges, elected for six-year terms, and 20 circuit judges, holding jurisdiction over 12 districts and elected for four-year terms.

**State Finance.** Receipts of state money from all sources for the fiscal year ending June 30, 1951, amounted to $71,689,000. This included $35,370,000 collected by the division of taxation and licensing, $3,818,000 collected by counties, and $15,183,000 received in federal aid. The collections of the division of taxation and licensing included $17,091,000 from retail sales and use tax, $1,300,000 from sales tax on liquor, beer, and cigarettes, $11,119,000 from motor vehicle fuels, $2,702,000 from motor vehicles and operators, $51,000 from chain stores, $2,129,000 from liquor licenses, and $711,000 from ore tax. The revenues collected by the counties included $1,935,000 from general property tax and $502,000 from inheritance tax. Federal aid included $6,546,000 for highways, $3,633,000 for old-age assistance, and $1,191,000 for other forms of public welfare.

General expenditures for the fiscal year ending June 30, 1951, totaled $69,068,795, and included $8,394,000 for interest and sinking fund, $17,632,000 for highways, $8,062,000 for educational institutions, $2,792,000 for penal and charitable institutions, $9,383,000 for public welfare, and $11,865,000 to governmental subdivisions.

The bonded indebtedness at the end of the fiscal year 1951 was $20,815,000, representing veterans' bonus and rural credit bonds; a sinking fund of $17,775,000 assured the liquidation of the entire debt by 1954.

**Military Organization.** The reorganization of the National Guard was undertaken in 1946. It consisted of a regiment of infantry, a battalion of field artillery, a battalion of combat engineers, a company of engineers, an air force fighter squadron, and an army band. The organization is administered by a state headquarters under the adjutant general. During 1950 and 1951 three units were ordered to active duty but were all returned to state control by Dec. 1, 1952, at which time they were reorganized with an authorized personnel of 1,854 men and officers.

## SOCIAL AND CULTURAL ACTIVITIES

**Education.** The public school system is headed by the Superintendent of Public Instruction, elected for a two-year term on a nonpolitical ballot, and comprises 3,390 districts, including 3,039 common, 264 independent, and 87 consolidated districts. The total cost of maintenance in 1951-1952 was $30,746,494. Local school levies are supplemented by state aid in the form of income derived from the permanent school fund and rentals on school lands and by direct legis-

COURTESY OF THE *Minneapolis Tribune* AND THE MILLER STUDIO

*AIR VIEW OF PIERRE, STATE CAPITAL OF SOUTH DAKOTA. THE STATELY CAPITOL, SHOWN IN THE INSET, IS SURROUNDED BY PARKLIKE GARDENS.*

lative appropriations which in 1951 amounted to $3,500,000 for the biennium.

Attendance at school in South Dakota is compulsory for all children from seven to sixteen years of age inclusive. In 1951-1952 the public elementary schools enrolled 91,975 pupils; the public secondary schools enrolled 29,475 pupils. The public schools of the state employed 1,704 men teachers in the same year, and 5,517 women teachers.

Seven institutions of higher learning are maintained by the state under the governance of a board of regents, consisting of 5 members appointed for six-year terms: the University of South Dakota, at Vermillion; the South Dakota State College of Agriculture and Mechanic Arts, at Brookings; The South Dakota School of Mines and Technology, at Rapid City; Black Hills Teachers College, at Spearfish; General Beadle State Teachers College, at Madison; Northern State Teachers College, at Aberdeen; and Southern State Teachers College, at Springfield. Private institutions of higher learning include Augustana College, at Sioux Falls; Dakota Wesleyan University, at Mitchell; Huron College, at Huron; and Yankton College, at Yankton.

**Social Measures.** The Public Welfare Commission of the state administers old-age assistance, aid to the blind, and aid to dependent children. The care of other poor persons remains the responsibility of the county commissioners of each county. Old-age assistance is provided to persons sixty-five years of age or over who have resided in South Dakota for one year immediately preceding application and do not have sufficient income or other resources to provide "a reasonable subsistence compatible with decency and health." Payments were made during the fiscal year of 1951-1952 to 11,983 aged persons in the total amount of $5,938,000. During the same period an average per month of 2,556 families received payments for dependent children totaling $2,191,000. In the same year payments amounting to $99,308 were made to an average of 213 blind persons per month, and payments of $62,427 were made to 152 disabled persons. Unemployment insurance benefits begin in South Dakota at a minimum of six dollars a week for a period of ten weeks and progress to a maximum amount of $20 a week for twenty weeks. During 1951 the Employment Security Department collected the sum of $1,620,000 in taxes from employers and paid $714,610 in unemployment benefits to 4,434 persons.

Charitable and penal institutions maintained by the state include the School for the Blind at Gary, the School for the Deaf at Sioux Falls, the School and Home for the Feebleminded at Redfield, the State Hospital for the Insane at Yankton, the State Soldiers' Home at Hot Springs, the State Sanatorium at Sanator, the State Training School at Plankinton, and a penitentiary at Sioux Falls. As of Oct. 1, 1952, there were 74 general hospitals in the state providing a total of 3,010 beds.

## POPULATION

**General Statistics.** According to the United States Census, South Dakota had a population of 652,740 in 1950, ranking it forty-first in population among the states, compared with 642,961 in 1940. The density of population in 1950 was 8.5 persons per square mile. Of the 1950 population, 216,710, or 33.2 per cent, were classified as urban. In 1950 the most populous county was Minnehaha, which includes Sioux Falls, the largest city; it contained a total of 70,910 persons. Pennington County, ranking second with 34,053 persons and containing Rapid City, had the most rapid rate of growth with an increase of 43.1 per cent for the ten-year period. Brown County, including Aberdeen, ranked third with 29,676. The leading cities in 1950 were Sioux Falls (52,696), Rapid City (25,310), and Aberdeen (21,051). Other cities with a population of over 10,000 were Huron (12,788), Watertown (12,699), Mitchell (12,123).

**Racial and Religious Groups.** In 1940, 96.3 per cent of the population was listed as white. The Indian population in 1950 was 23,344, concentrated mostly in eight reservation areas. The large influx of European immigrants was reflected in a high percentage of foreign born in the census records prior to 1900, constituting 22 per cent of the total population in 1890. By 1940 only 44,054, or 6.9 per cent,

were so listed. These included 8,708 from Norway, 8,304 from Germany, 6,468 from Russia, 4,361 from Sweden, and 3,721 from Denmark. According to the state census of 1945, the leading religious denominations and their respective memberships were Lutheran, 147,448; Roman Catholic, 91,835; Methodist Episcopal, 65,557; Presbyterian, 26,579; and Congregational, 26,150.

**Occupational Groups.** In 1940 there were 477,255 persons in the state over 14 years of age; of the 239,826 in the labor force, 204,514 were employed, of which nearly half, or 48.1 per cent, were employed in agriculture. The wholesale and retail trade constituted the next largest occupational group with 14.7 per cent. Professional and related services accounted for 8.8 per cent; personal services, for 5.7 per cent, and manufacturing, 4.5 per cent.

## FAMOUS SITES AND PLACES

Most of the Black Hills area is contained within the boundaries of the Black Hills National Forest, the Harney National Forest, and Wind Cave National Park. Custer State Park is one of the largest state parks in the United States. The Badlands National Monument, administered by the National Park Service, comprises 154,119 acres in a strip 40 mi. long and 5 to 20 mi. wide in the White River Badlands. In the Black Hills is also located Mount Rushmore National Memorial consisting of busts of George Washington, Thomas Jefferson, Abraham Lincoln, and Theodore Roosevelt carved by Gutzon Borglum out of the massive granite face of a mountain 6,050 ft. high. Other historic sites are Jewel Cave National Monument, which exhibits a variety of crystalline formations, and Fossil Cycad National Monument, which contains many fine petrified ferns.

## HISTORY

**Exploration.** The expedition of 1742-1743, headed by the French Sieur de La Vérendrye and his two sons, is the first recorded contact of Europeans with the region, although French explorers may have reached the eastern border as early as 1682. The principal Indian inhabitants during the early period were the Arikaras, who lived in villages of earthen lodges along the Missouri in the central part of the state, and the various divisions of the Sioux or Dakota who entered the region from Minnesota after 1750.

**Early Nineteenth Century.** The United States acquired title under the Louisiana Purchase of 1803. Following the Lewis and Clark expedition to the Oregon coast during 1804-1806, the American fur traders extended their operations into the upper Missouri Valley. South Dakota became studded with trading posts, especially along the Missouri where Fort Pierre, established in 1832, became a leading post of the Upper Missouri Outfit, a subsidiary of the American Fur Company. The arrival of the *Yellowstone* at Fort Pierre in June 1831 marked the introduction of steamboat navigation to the upper Missouri River basin. The first attempt at permanent settlement was made by town-site speculators in the Big Sioux Valley in 1857. Their effort to establish a territorial government failed, and the outbreak of hostilities among the Santee Sioux in Minnesota in 1862 led to the temporary abandonment of the Sioux Falls town site. Permanent settlements were planted at Vermillion and Yankton in 1859 following the relinquishment of title to the region by the Yankton Sioux under a treaty signed in 1858.

**Territorial Period.** Dakota Territory was created by Congress on March 2, 1861, and the first legislature convened in March 1862. Indian wars, droughts, grasshopper plagues, and lack of transportation facilities retarded the growth of the territory prior to 1868. Construction of a railroad from Sioux City to Yankton in 1872 and 1873 and an influx of European immigrants including Bohemians, Germans, Russians, and Scandinavians were factors in the growth that followed.

**Gold Rush.** During the 1870's a gold rush created a mining community in the Black Hills and furnished wide publicity for the entire territory. The Black Hills region was a part of the Great Sioux Reservation created west of the Missouri River by the Sioux treaty of 1868. The discovery of gold by two miners who accompanied the military expedition of General George A. Custer into the Black Hills in July 1874 caused a stampede into the area in violation of the treaty. The first party of miners reached French Creek near the present site of the city of Custer on Dec. 28, 1874. When the presence of gold in paying quantities was confirmed by the geological expedition headed by Walter P. Jenney in 1875, the government ceased trying to eject the miners. The Indian hostilities that followed culminated in the battle of the Little Big Horn on June 25, 1876, when General Custer's command was annihilated by Chiefs Sitting Bull and Crazy Horse. The treaty of 1877 ended the conflict and provided for the cession of the area west of 103° W. long., including the entire Black Hills region, and the right of way for three wagon roads across the reduced reservation. The peak of the gold rush was reached in 1877 when quartz mining replaced the placer operations.

**Great Dakota Boom.** The gold rush was followed by the "Great Dakota Boom," which increased the population from 98,268 in 1880 to 348,600 in 1890 and resulted in the complete occupation of the eastern half of the state during the period from 1877 to 1886. The penetration of this area by the railroads was a major factor, but favorable weather conditions and a liberal public land policy also contributed to the boom. This was followed by a period of drought and the financial depression of the 1890's, which resulted in a sharp decline in the population. There was also a marked shift from wheat culture to crop diversification during the recession.

**Statehood.** A movement for statehood and the division of

*A stone monument erected at Fort Pierre, South Dakota, marks the ground in which the Vérendryes in 1743 buried a lead tablet to claim the region for France. This tablet, found in 1913, is the first written record of the visit of white men to South Dakota.*

COURTESY OF THE SOUTH DAKOTA STATE PUBLICITY DEPARTMENT

Dakota Territory was initiated as early as 1877. A citizens' convention, organized by the southern counties of the territory, met at Sioux Falls in 1883 to draw up a constitution which was endorsed by the voters. Two years later another convention drafted a second constitution. The voters in the southern half likewise endorsed the constitution of 1885 and actually elected a full slate of state officials, including a legislature which met at Huron to place the claims for statehood before the country. In the meantime, partisan opposition to division in both the northern counties and Congress served to delay Congressional action. After the national election of 1888 which resulted in a Republican victory, the Democratic Party abandoned its opposition. Following the enactment of the enabling act in February 1889, providing for division at the seventh standard parallel, a third constitutional convention met at Sioux Falls in May 1889 to readopt the constitution of 1885 except for certain revisions required by Congress. On Nov. 2, 1889, South Dakota became the fortieth state, with A. C. Mellette as the first governor. The selection of Pierre as temporary capital was made permanent in a spirited contest with Huron, Watertown, Sioux Falls, Mitchell, and Chamberlain in 1890, and again with Mitchell in 1904.

During the first decade of statehood additional areas were opened to settlement on a portion of the Great Sioux reservation as well as on the Sisseton and Yankton reservations, but adverse climatic and economic conditions prevented a boom. The western plains remained an important part of the northern cow country although the open range industry had given way to modern forms of ranching. The economic and political unrest of the period was reflected in the Populist movement growing out of the Farmers' Alliance, which became a potent organization of protest in the Dakotas. Fusion with the Democrats and Free Silver Republicans in 1896 and 1898 resulted in the election of a Populist governor. Legislative efforts to regulate railroads failed, but the adoption of the first initiative and referendum law in the United States in 1898 was a direct contribution of the Populist movement.

*SYLVAN LAKE IN THE BLACK HILLS OF SOUTH DAKOTA*

COURTESY OF THE CHICAGO, BURLINGTON & QUINCY RAILROAD

**Twentieth Century.** Economic conditions improved after 1900. A combination of circumstances brought about another boom. Weather conditions were again favorable. Improved financial conditions and a heavy influx of homesteaders in the region west of the Missouri, particularly on newly opened Indian lands, led to the resumption of railroad construction. Lines were built from Pierre and Chamberlain to Rapid City in 1906 and 1907. The Chicago, Milwaukee and St. Paul also pushed its transcontinental line from the Missouri River at Mobridge along the northern edge of the state into North Dakota. The population of the state increased from 401,570 to 583,888, or 45 per cent, between the years 1900 and 1910.

The boom was temporarily interrupted by intense drought in 1910 and 1911, resulting in an exodus of many homesteaders from the Great Plains area where cropping methods were not suited to the region. The return of favorable weather conditions, however, accompanied by the stimulus of World War I and the increased use of power machinery, led to a tremendous expansion of agriculture which, in turn, resulted in over-production and inflated real estate values as well as the further extension of grain crops into grazing areas. The state was consequently hard hit by the deflation of the 1920's and the severe drought that set in after 1930. The intensity of this agricultural depression was indicated by the large relief roll in 1935 and the failure of two-thirds of the state's banks between 1920 and 1935.

Through the application of land-conservation methods and the introduction of scientific land-use programs, the farming situation greatly improved, so that by the end of World War II farm tenancy had declined, bank deposits had reached an all-time high, and farm mortgage indebtedness was at a low level.

Under the Flood Control Act passed by Congress in 1944, a vast program was authorized for the comprehensive development of the Missouri River basin, which, in South Dakota, included four multiple-purpose dams on the main stem of the Missouri and the construction of seven reservoirs for irrigation. The Fort Randall dam near the Nebraska boundary line was started on July 30, 1946, to supply large areas in South Dakota and Nebraska with electric power as well as to alleviate danger from the periodic floods to which the Missouri Valley has been subjected. Construction on the Oahe Dam, 7 mi. north of Pierre, was started on Sept. 16, 1948. H. S. S.

**SOUTH DAKOTA, UNIVERSITY OF,** an accredited, coeducational, publicly controlled institution occupying 62 acres of land in Vermillion, S.D. It was started as the University of Dakota by an act of the first territorial legislature in 1862, and the act incorporating the university was passed at the next session. In 1881 seventy-two sections of public land were granted by Congress for the use and support of the university, an endowment consisting of about 80,000 acres. First instruction was given in 1882. The divisions founded since that time are: the College of Arts and Sciences, 1888; the School of Law, 1901; the School of Medicine, 1907; the School of Education, 1927; the School of Business Administration, 1927; the Graduate School, 1929; and the College of Fine Arts, 1929. Among the degrees offered are the A.B. in liberal arts; the B.F.A.; the B.S. in business administration; the B.S. in medicine, which includes two years of preprofessional work; and the B.S. in education. Graduate

work leading to the A.M., Ed.M., and the M.Mus. is given in the Graduate School. The local chapter of Phi Beta Kappa was established in 1926.

Some scholarship and fellowship assistance is offered. However, most of it is restricted to applicants from South Dakota. Opportunities for self-help enable approximately one third of the students to earn part of their expenses. There are dormitories for women but none for men. Fraternities and sororities maintain residences for their members. *For statistics see* COLLEGES AND UNIVERSITIES. J. R. To.

**SOUTH DAKOTA SCHOOL OF MINES AND TECHNOLOGY,** an accredited, coeducational, state-controlled technological school occupying 100 acres in Rapid City, S. D. It was established by the Dakota Territorial Legislature as the Dakota School of Mines in 1885, and first instruction was offered two years later. Although the college is a coeducational institution, very few women enroll. The degrees offered are the B.S. in chemistry, in physics, and in chemical, civil, electrical, general, geological, mechanical, metallurgical, and mining engineering, and the M.S. in engineering. To qualify for the M.S. in engineering, candidates must have the bachelor's degree from the South Dakota School of Mines and Technology, five years' successful experience in a responsible technical position, and must submit a thesis. There is very little scholarship aid, but many students find it possible to earn part of their expenses. Some dormitories are provided and members may live in campus fraternity houses. *For statistics see* COLLEGES AND UNIVERSITIES. J. R. To.

**SOUTH DAKOTA STATE COLLEGE OF AGRICULTURE AND MECHANIC ARTS,** an accredited, coeducational, state-controlled technological college occupying a 40-acre campus in Brookings, S. D. It was chartered as Dakota Agricultural College in 1883, and first instruction was given in the following year. The name was changed to the State College of Agriculture and Mechanic Arts in 1907. In 1924 the institution was organized into five divisions: agriculture (instructional, experiment station, and agricultural extension); engineering; home economics; pharmacy; and general science. Degrees offered include the B.S. in engineering, general science, agriculture, pharmacy, home economics, printing, and journalism, and the M.S. Graduate and undergraduate scholarship aid is available and there is a loan fund. Many students find opportunities to earn part of their expenses. Male freshmen and sophomores and all women not living at home must live in dormitories. There are no fraternities or sororities on campus. *For statistics see* COLLEGES AND UNIVERSITIES. J. R. To.

**SOUTHEAST ASIATIC AND JAVANESE ART.** Under the title of "Southeast Asiatic and Javanese Art" we may include the art of the regions designated by the modern geographical names of Ceylon, Siam, Indochina, and Java. The beginnings of the art of all these outposts of Indian civilization date from the introduction of Buddhism and Hinduism, with the attendant importation from the Indian mainland of completely developed iconographical and stylistic canons.

### CEYLON

**Early Period.** Art in Ceylon may be said to begin with the introduction of Buddhism by the son of the Indian Emperor Aśoka in the third century B.C. Although the dedication of many religious structures and even Buddhist images is traditionally ascribed to the first century after the introduction of Buddhism, the real florescence of art in Ceylon begins with the establishment of the capital at Anuradhapura in the first century B.C. Among the earliest foundations were the enormous brick mounds or dagabas constructed to enclose corporeal relics of the Buddha. They retain the essential form of the Indian stupa with its characteristic hemispherical dome and superstructure of umbrellas on a mast emerging from the summit of the cupola. In scale they approximate the dimensions of all but the largest Egyptian pyramids.

EWING GALLOWAY

*The Buddha Tooth, enshrined in the Temple of Dalada Maligawa, at Kandy, Ceylon, is contained in a bell-shaped cover encrusted with hundreds of precious stones.*

The earliest sculpture at Anuradhapura dates from the second to the fifth century A.D. and consists of extremely hieratic and monumental Buddhist images in a style clearly derived from the contemporary Indian sculpture under the Later Andhra Dynasty, on the southeast coast of India.

The one monument of painting from this earliest period of Singhalese art is the series of wall paintings that formed a part of the decoration of the palace of Karsapa I at Sigiriya in central Ceylon. The wall paintings, located in a pocket in the vertical cliff, represent Apsarases, or celestial maidens. The figures are extremely sensuous in effect; they are a kind of Singhalese version of the style of the Indian wall paintings of the Gupta period at Ajanta.

**Later (Medieval) Period.** What is often described as the medieval period of Singhalese art begins with the abandonment of Anuradhapura to Tamil invaders from South India in the eighth century and the establishment of the capital at Polonnarūwa. The last great florescence of Singhalese art dates from the reign of Parākrama Bāhu (1164-1197). The sculpture of this period, as exemplified by the colossal Nirvana group of the Gal Vihāra, reveals a persistence of the traditions of the Gupta style and a peculiarly moving

presentation of the Buddha's serenity that can only be described as a special Singhalese contribution to Buddhist art. The colossal portrait statue of the king Parākrama Bāhu at Polonnarūwa is an impressive work of artistic genius.

Among the buildings at Polonnarūwa is a pyramidal temple or *prasada* built for the king's Cambodian mercenaries. A number of other structures, notably the circular Potgul Vihāra, are remarkable for their great beauty of proportion and the use of relief friezes to ornament the otherwise unadorned stone surfaces of the façades.

## INDOCHINA AND SIAM

**Pre-Khmer Period.** The history of art in Siam and Cambodia involves the transformation of originally Indian forms by peoples whose artistic capacity was in every sense equal to the task of evolving modes of expression suitable to the needs of their religion and environment. When Indian Hindu and Buddhist missionaries first made their way to the earliest centers of the Siamese and Cambodian civilizations, they brought with them the ready-made receipts for religious imagery developed in India in the Gupta period, so that some of the Buddha statues unearthed at the first Siamese capital of Dvāravatī and the earliest Cambodian shrines at Sambor seem to be repetitions in local stone of Indian models. Certain other statues of the pre-Khmer period, notably a magnificent image of the Hindu deity Hari-Hara in the museum at Phnom Penh, are distinguished by an almost Egyptian feeling for the sheer abstract mass and volume of the plastic form. The slightly unbalanced, almost momentary pose of the figure and the rhythmic articulation of parts and whole communicate to the statue a feeling of tense aliveness and imminent movement that is perhaps to be interpreted as an indication of the influence of the religious dance on the plastic arts in farther India.

R. MOULIN FROM EWING GALLOWAY

*The Buddhas of Wat Benchamabopitr, a temple in Bangkok, Siam*

The development of architecture in Cambodia, like the history of sculpture in this same region, reveals the evolution of a completely national style on a foundation of Indian origin. The earliest sanctuaries of the sixth and seventh centuries are isolated brick or laterite towers, each containing a single cella for the cult image. The towerlike structure is faintly reminiscent of the Indian *sikkhāra,* and certain details of the architectural decoration have close parallels in the Pallava architecture of southeast India. All the buildings of this period bear out the testimony of contemporary inscriptions to an intimate connection with the Pallava culture, the inheritor of Gupta civilization in southeast India.

**Classic Period.** The history of sculpture in Indochina and Siam continues with the establishment of the power of the Khmer people; it is marked by the development of an art that is distinctly national in style and iconography. The sculptors' realization of the cubic mass of the image is no less notable in the Early Classic statues of the ninth and tenth centuries than it was in the masterpieces of the pre-Khmer period. It seems almost certain that the stocky physical type seen in Buddhist and Hindu images alike is the reflection of a Khmer racial characteristic with no relation to any Indian canon of divine proportion. The same is probably true of the square, blocklike heads and of certain features, such as the enormously full and wide lips. The portraitlike character of many of the statues is due to the cult of the *deva-rāja* (god-king) in which the sovereign was regarded as an earthly manifestation of the deity. In the art of these centuries we may discern the evolution of what ultimately becomes a Khmer formula for representing the beatitude and inner serenity of the divinities: the eyelids are closed in reverie, and the lips are curled in a long, slow smile. This formula tends to assume the character of a rigid formalized mannerism in the last examples of Khmer sculpture that filled the great temple-tomb of Angkor Vat (twelfth century) and in the giant heads of Lokeśvara that ornament the thirteenth century shrine of the Bayon. An exactly parallel development seems to have taken place in Siam with the result that, except for certain local peculiarities, the statues carved at the Siamese capital of Lopburi are hardly to be distinguished from the contemporary sculpture of Angkor.

Although the earliest examples of relief sculpture in Cambodia show a dependence on motifs of Indian origin, it was not long before the native carvers displayed very marked stylistic and iconographical innovations of their own. The sculptors developed a technique of decorating the façades of buildings with continuous friezes of relief, which appear to have been carved directly on the face of the building after the blocks of the structure were already in place. The paneled reliefs that decorate the tenth-century palace of Phimeanakas at Angkor are a continuation of the classic Indian style of the Gupta period and show a feeling for action and dramatic narration that are purely indigenous. In its final development, the technique of the frieze assumes a definitely pictorial character, as may be illustrated by the carvings of Hindu epics that clothe the walls of the lower galleries of Angkor Vat like tapestries. In the carving of lintels and tympana, the Khmer sculptures reveal an exuberance of ornament and precision of carving that are as original as they are unparalleled in the art of the Orient.

The architecture of the Classic period, which begins with the consolidation of Khmer power under Jayavarman II in 802, is marked by the emergence of truly national characteristics in building: the isolated sanctuary is now constructed almost entirely of laterite and is placed on the summit of a stepped pyramid. This pyramid or *prasada* is a symbolical

architectural replica of the world mountain that supports the paradise of the gods. Such pyramidal foundations were used also for secular structures, as in the case of the palace of Phimeanakas in the first Khmer capital at Angkor. The palace itself was of wood and has long since vanished, but there are indications that during the Classic period the Cambodian architects began to imitate elements of native wooden architecture in stone. It could be said that the greatest Khmer contribution to architecture is in the development of the ground plan. Since the vault was never developed beyond the most primitive corbel stage, it was impossible for the Cambodian builders to cover large interior spaces; and so, when the need arose for larger and more complex sanctuaries, they met the problem by joining many small units into an integrated whole. The first step toward the final solution is to be seen at Banteiai Srei, where a number of stone towers are grouped around a temple courtyard. At Ta Keo the towers, each containing a single image cell, are elevated by an enormous pyramid of stone and are joined by galleries that completely girdle the perimeter of the platform.

The culmination of the Khmer genius in building is achieved in the great temple-tomb of Sūryavarman II (1112-1152), the world-famous monument of Angkor Vat. The monument is laid out on a rectangular plan surrounded by a moat nearly fifteen miles in circumference. The ground floor consists of a vast gallery nearly a mile in extent; an inner court on a higher level is reached by entrances on all four sides. In the center of this enclosure rises a mountainous pyramid, which supports a central tower 250 feet in height with smaller towers of the same form at the four corners. This temple marks the culmination of tendencies toward combining vertical and horizontal elements already detected in earlier building. Even in a gigantic structure like this, the vaulting of the separate elements is of the most primitive corbel type, reinforced by wooden beams hidden in the stone masonry. It is the cruciform plan with the arms joining the enclosing galleries that makes possible this new and grandiose ensemble composed of multiple small elements. Many tricks of illusionistic perspective are employed in the building in order to give greater scale to the central mass. The central tower originally contained a statue of the king in the form of the god Vishnu, and the subsidiary towers had statues of other forms of Vishnu in the likenesses of the king's ministers. The reliefs covering the ground floor gallery are partly historical and partly episodes from the Vishnu legend, which bore a resemblance to events from the life of Vishnu's earthly incarnation, Sūryavarman.

The last Khmer building of any size to be built was the temple of the Bayon, which came to be the center of the capital of Angkor Thom. In its final form, as completed by Jayavarman VII (1181-1201), the sanctuary is a temple-mountain raised above a cruciform plan enclosed within a square. The most striking feature of this monument consists in the giant faces of the Bodhisattava Lokeśvara carved on the four faces of each tower, which were intended magically to proclaim the power of this divinity over the four quarters of the world. The temple was the magic center of the Cambodian realm and the shrine of the sovereign as the earthly avatar of Lokeśvara. The entire edifice, from the statuelike towers to the walls of the outer galleries, is literally covered with sculpture. This marks the culmination of a tendency—already threatened at Angkor Vat—in which the carving has completely engulfed the architecture itself. The whole building has a baroque, unstable quality, which is echoed in the very hasty and unsound construction that marks the end and exhaustion of a great civilization.

BURTON HOLMES FROM EWING GALLOWAY

*Throne Hall, a magnificent building of Occidental design, was the scene of the coronation of Prajadhipok, monarch of Siam, in Bangkok.*

**Modern Period.** The Siamese conquest of Angkor in the fifteenth century marked the end of the Khmer civilization. The later history of architecture here is marked by the disappearance of monumental concepts of the Classic period, a reversion to wooden construction, and, above all, an assimilation of elements of design from many foreign sources: Chinese, Burmese, and even European. Modern Siamese architecture is a baroque conglomerate of traditional and foreign forms, characterized by the brilliant polychromatic decoration of the buildings in glass and porcelain mosaic.

## JAVA

The great period of Javanese art comes in the eighth and ninth centuries of the Christian Era, when Java and Sumatra were under the rule of the Śailendra kings, whose conquest of Indonesia established Mahāyāna Buddhism as the religion of the realm. There are, to be sure, some monuments of Hindu sculpture and architecture testifying to earlier Hindu colonization, but none can compare to the great temple of Barobudur that rises on the plains of south central Java. This sanctuary is really a rounded hill, terraced and clothed in stone, consisting of five terraces on a rectangular plan; above these are three round platforms on which are seventy-two bell-shaped latticed stupas and a sealed terminal stupa at the very summit of the monument; a ninth story is present, though unseen, in the form of a hidden basement. The total mass is a dome cut by galleries, which disappear from view if the monument is looked at in profile, when the outline becomes that of a stupa. In other words, we have a pyramid inside a stupa, an arrangement intended to reproduce symbolically in architecture the Indian concept of the sky as a

solid bowl covering the world-mountain Meru. The temple is a *mandala* or magic diagram of the material and spiritual worlds manifested in the universal Buddha Vairocana, whose image was enshrined in the closed bell-shaped stupa at the top of the monument. The subject matter of the reliefs of the successive galleries begins with representations from the World of Desire, in the lower stories, and culminates, in the upper corridors, in the representation of the spiritual world without form and action. The symbolism of the monument is completed by the statues of the mystic Buddhas in latticed stupas and by the Buddhas of the four directions that fill the niches on the four sides of the building. The style of the reliefs of the galleries, echoing the hieratic progression of their subject matter, begins with a direct and even naturalistic treatment of subjects from the World of Desire and progresses to a completely abstract diagrammatic representation of the realms of the mystic Buddhas in the uppermost corridor. The Buddha images may be compared with the masterpieces of Gupta art in India: they represent such a beautiful realization of plastic mass and breathing life, combined with a crystalline simplicity of expression, that they rank among the greatest expressions of sculptural genius in the world.

B. Ro.

**SOUTHEND-ON-SEA,** a county and parliamentary borough in Essex, England, 42 mi. east of London. Picturesquely situated on the Essex bank of the River Thames, it is a seaport and one of the nearest popular seaside resorts to London. Southend-on-Sea, incorporated in 1892, was made a county borough in 1914 and a parliamentary borough in 1918. Interesting buildings include a thirteenth-century castle and, near by, the Cranham Church, where General James Edward Oglethorpe, founder of Georgia, is buried. Manufactures include paint, pharmaceuticals, electrical appliances, and metal products. The town returns two members to Parliament. Pop. 1954, 151,500. A. W.

**SOUTHERN ALPS,** a picturesque chain of mountains forming the mountain backbone of South Island, New Zealand. The chain parallels the longitudinal axis of the island, and lies somewhat nearer the west coast than the east. Narrowing in the center to a single range of mountains, it fans out in the northeastern and southwestern parts of the island like the spokes of a wheel, forming several diverging ranges between which are deeply incised valleys and, near the coast, small triangular or crescent-shaped patches of alluvial lowland. The chain contains more than 220 named peaks over 7,500 ft. high, culminating in Mount Cook, which rises to 12,349 ft. The central part of the chain, the Mount Cook Range, contains many glaciers. The largest of these, the Tasman Glacier, is about 20 mi. long and over a mile wide. Other notable glaciers include the Mueller, Hooker, Godley, and Murchison, which grind their way slowly down the eastern slopes and terminate some 4,000 ft. above sea level; and the Fox and Franz Josef glaciers on the western slopes of the chain, which descend much more steeply and reach to within 700 ft. of sea level. The Southern Alps are important as a tourist attraction, as a source of irrigation water, and as a wild-life refuge and game preserve. Some lumbering and mining is carried on locally on their lower slopes and in the adjacent foothill belt. R. G. B.

**SOUTHERN CALIFORNIA, UNIVERSITY OF,** an accredited, coeducational, privately-controlled institution occupying a 50-acre campus about 3 mi. from the business section of Los Angeles, Calif. The charter was granted in 1880, when first instruction was given in the College of Letters, Arts, and Sciences. The numerous other divisions of the university were added as follows: School of Music, 1887; Graduate School of Religion, 1887; School of Law, 1896; College of Dentistry, 1897; College of Pharmacy, 1905; Summer Session, 1912; School of Education, 1918; Graduate School, 1920; University College, 1924; Los Angeles University of International Relations, affiliated 1924; College of Architecture, 1925; College of Engineering, 1927; School of Medicine, 1928; School of Public Administration, 1929; School of Philosophy, 1929; School of Journalism, 1933; Graduate School of Library Science, 1936; Allen Hancock Foundation for Scientific Research, 1938; School of Nursing, affiliated 1941; College of Aeronautics, 1945; and Institute of the Arts, 1946. The local chapter of Phi Beta Kappa was organized in 1929.

Degrees offered include the bachelor's degree in the various curricula, the LL.B., the B.S. in library science, the M.A., the Ph.D., the D.D.S., and the M.D. A new degree, Doctor of Public Administration, offered for the first time in 1950, carries requirements that are comparable to those of the Ph.D.; its three-year program includes work in government organization, management, administrative analysis, personnel, and financial administration.

Scholarship assistance is available; however, most of it is restricted to residents of California. A fund is available for student loans. Opportunities for self-help enable approximately one third of the students to earn part of their expenses. Residence halls and fraternity houses offer living facilities to a limited number of students. All lower-division students must live in residence halls or in approved houses. *For statistics see* COLLEGES AND UNIVERSITIES. J. R. To.

**SOUTHERN CROSS.** *See* CRUX.

**SOUTHERNE, THOMAS** [sʌ′thərn] (1660-1746), English dramatist, was born at Oxmantown, near Dublin, in 1660. His first play, *The Loyal Brother* (1682), was a heroic tragedy. His more popular plays—*The Fatal Marriage* (1694) and *Oroonoko* (1695), both based on novels by Aphra Behn—mingle the heroic and Shakespearean tragedy with the sentimental and pathetic, in accordance with the newer dramatic trend. He died on May 22, 1746, and is buried in St. Margaret's Church in Westminster.

E. L. A.

**SOUTHERN LIGHTS.** *See* AURORA BOREALIS AND AURORA AUSTRALIS.

**SOUTHERN METHODIST UNIVERSITY,** an accredited, coeducational university controlled by the Methodist Church. It is located on a 133-acre campus in University Park, a residential area near Dallas, Texas. The charter was granted in 1911 and first instruction was given in 1915. The original organization was made up of the College of Arts and Sciences, the Graduate School, the Perkins School of Theology, and the School of Music. The School of Law and the School of Engineering were established in 1925, and the School of Business Administration in 1941.

The degrees offered include the A.B., the B.B.A., the B.S. in mechanical, civil, and electrical engineering, the B.D., the B.Mus., the LL.B., the M.B.A., and the M.A. Some engineering programs have co-operative work-and-study courses which delay the degree one year.

Many graduate fellowships and undergraduate scholarships are available and there is a large loan fund. Opportunities for self-help enable approximately half of the students to earn part of their expenses. Dormitories and dining halls are

provided. The men's fraternity houses provide living quarters for their members. *For statistics see* COLLEGES AND UNIVERSITIES. J. R. To.

**SOUTHERN RHODESIA.** *See* RHODESIA.

**SOUTHERN UNIVERSITY AND AGRICULTURAL AND MECHANICAL COLLEGE,** an accredited, coeducational, state-controlled land-grant university for Negroes, occupying a campus of over 500 acres in Scotlandville, La., near Baton Rouge. It was chartered in 1880 as Southern University by the general assembly of Louisiana at New Orleans. First instruction was given in 1883. The name was changed to the present form and the college moved to Scotlandville in 1914. The various divisions of the college were founded as follows: arts and sciences, 1883; agricultural, home economics, and mechanic arts, 1914; physical education, 1936; commercial education, 1937; music, 1938; law, 1947. The degrees offered include the A.B. and the B.S. in liberal arts, the B.S. in business, the B.S. in agriculture, the A.B. and the B.S. in education, the B.S. in nursery school education, animal husbandry, health and physical education, mechanic arts, and foods and nutrition.

Scholarship aid in the form of small stipends is available. Opportunities for self-help enable some of the students to earn part of their expenses. Dormitories and dining halls are provided. The sororities and fraternities do not have houses for their members. *For statistics see* COLLEGES AND UNIVERSITIES. J. R. To.

**SOUTH EUCLID** [yu'klɪd], a city in Cuyahoga County, in northeastern Ohio, about 9 mi. east of Cleveland, of which it is a residential suburb. Founded in 1917 and incorporated as a city in 1940, South Euclid is administered by a mayor and council. It is the seat of Notre Dame College for women and the Rainbow Hospital for crippled children. Pop. 1950, 15,432.

**SOUTHEY, ROBERT** [sau'thi; sʌ'thi] (1774-1843), English poet, historian, and man of letters, was born at Bristol, Aug. 12, 1774, coming from a line of respectable and undistinguished yeomen. He spent much of his childhood with an aunt who was despotic and whimsical, but in a small way was a patroness of the drama. After desultory schooling, supplemented by his own reading and by experiments with plays and poems, he matriculated at Oxford to study for the Church, later for medicine, and still later for law; but none of these careers satisfied him. Meanwhile, he met Samuel Taylor Coleridge and Charles Lamb, and continued his writing, which was now fired with an enthusiasm for the ideals of the French Revolution. After marrying Edith Fricker, Mrs. Coleridge's sister, and deciding upon a literary life, Southey settled with Coleridge in 1803 at Keswick, in the Lake District, and almost at once assumed the support of both families. Thereafter his life was devoted to a daily regimen of writing poetry, reviewing, and collecting materials for histories and biographies. He was named Poet Laureate in 1813, but he refused all other public recognition and appointments, the better to pursue writing. In 1839, after the death of his first wife, he married Caroline Anne Bowles. He died at Keswick, March 21, 1843, worn out in mind and body.

In his own day, Southey's long epic poems received favorable notice from Scott, Wordsworth, and Coleridge, and Southey placed his hopes of permanent fame on these. However, the shorter and less pretentious *Bishop Hatto, Battle of Blenheim,* and *His Books* have retained their popularity better than *Thalaba, Roderick,* and other poems of an epic character. Whatever the verdict on Southey's poetry may be, the merit of his biographies, histories, and reviews is undeniable, for his prose style is perspicuous and free of mannerisms, an ideal instrument for his thoughts. His histories of Portugal and Brazil, though admirable in their day, have been superseded; his *Life of Nelson* is delightful and sometimes masterful in its narrative skill, and his *Life of Wesley* closely rivals

ROBERT SOUTHEY

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it. *The Doctor,* a curious miscellany, displays his humor, a playful, restrained whimsicality. Perhaps the best view of Southey is to be gained, however, through his correspondence. There his morality and industry are displayed, and, in addition, the engaging qualities of smiling earnestness and modest and tolerant faith. R. G. Bo.

**SOUTH GATE,** an industrial city in southern California, located 7 mi. south of Los Angeles. South Gate, which was incorporated as a city in 1923, experienced a large increase in population between 1940 and 1947, attributable chiefly to the World War II concentration of industry in the Los Angeles area. The varied factory output includes automobiles, rubber tires, concrete, steel, chemicals, linoleum, screws, and airplane parts. Transportation is provided by the Pacific Electric, the Southern Pacific, and the Union Pacific railroads. Pop. 1950, 51,116.

**SOUTH GEORGIA ISLAND,** an island in the South Atlantic Ocean 800 mi. southeast of the Falkland Islands, of which it is a dependency. South Georgia Island is the base for the principal whaling industry of the world, and five whaling factories render the oils and convert bones and flesh into fertilizer. Most of the island's 1,450 sq. mi. are occupied by high snow-covered mountains and glacier-filled valleys. Grytviken Harbor is the principal settlement. The permanent population of 750 is composed chiefly of the Norwegian and Swedish crews of the whaling vessels which operate in Antarctic waters between October and March. Supplies are obtained and whale oil exported through Port Stanley in the Falklands. *See also* FALKLAND ISLANDS. P. E. J.

**SOUTH HADLEY,** a town in west central Massachusetts, situated in Hampshire Co., on the east bank of the Connecticut River, 12 mi. north of Springfield, in an area of diversified agriculture. Founded about 1659 as a part of the town of Hadley, it was incorporated as a separate town about

1775. The local government is the representative-town-meeting type. South Hadley is the seat of Mount Holyoke College for women, established in 1837. Transportation is provided by the New York, New Haven and Hartford and the Boston and Maine railroads at Holyoke, across the river. Pop. 1950 (town) 10,145; (village) 2,446.

**SOUTH HOLLAND,** a province in the west central Netherlands. South Holland, which has an area of 1,130 sq. mi., may be divided into a northern section, the mainland, and a southern section, consisting of a number of islands. It is bounded on the north by North Holland, on the east by Utrecht and Gelderland, on the south by North Brabant and Zeeland, and on the west by the North Sea. Except for the dunes on the west coast, most of the province is situated below sea level and must be protected by dikes. The Rijn (Rhine) River, which flows through South Holland, has been canalized, and there are considerable areas of reclaimed polder land. Other waterways include the Lek River and numerous canals.

General farming, cattle raising, and the cultivation of flower bulbs are carried on extensively. The mainland is mostly grassland suitable for pasturing, and the farmlands of the islands are used mostly for crop cultivation. The leading industrial cities are Rotterdam, Delft, Gouda, Schiedam, and Leiden, where there are sugar refineries, distilleries, brickworks, shipbuilding yards, machine shops, and petroleum refineries, vegetable-oil, margarine, and clothing factories, and furniture and ceramics plants. At Rotterdam is held the largest cattle market in the Netherlands, and cheese markets are held in Bodegraven, Woerden, Gouda, Leiden, and Oudewater. Rotterdam is the nation's greatest center of maritime and island shipping and is the port of transshipment for the transit trade up the Rhine to Germany. The capital of the province is The Hague, which is also the seat of the national government. Prominent seaside resorts are Katwijk aan Zee, Noordwijk-Binnen, Hoek van Holland, and Oostvoorne. Leiden has a state university which was founded in 1575; in Delft is the State Technical College; and the Netherlands Institute of Economics is in Rotterdam. Pop. 1952, 2,453,465. T. R.

**SOUTHINGTON** [sʌ′thɪŋtən], a town, including a village of the same name, in central Connecticut, situated in Hartford Co., 20 mi. north of New Haven, in an agricultural area marked by fruit, dairy, and poultry farms. Southington was incorporated as a town in 1779, and its government is administered by a mayor and council. Features of special interest are the Jonathan Root Tavern, which has a Dutch doorway reported to date from 1720; the Curtis-Robinson home, built about 1766; the collection of period furniture and historical relics in the library annex; and the Rogers orchards, with some 4,500 peach trees and 6,000 apple trees. Chief manufactures are hardware, tools, paper boxes, furniture, and airplane, automobile, and radio parts. Pop. 1950 (town) 13,061; (village) 5,955.

**SOUTH MILWAUKEE** [mɪlwɔ′ki], a city in Milwaukee Co., in southeastern Wisconsin, situated on the west shore of Lake Michigan at the mouth of Oak Creek, 10 mi. south of Milwaukee. Incorporated in 1897, the city is governed by a mayor and council. It is a manufacturing community, with transportation provided by the Chicago and North Western Railroad. The factory output includes malleable castings, excavating machinery, metal, tile, wood products, electrical devices, and shoes. Pop. 1950, 12,855.

**SOUTH OSSETIAN AUTONOMOUS OBLAST** [ɒsi′shiə], an administrative subdivision of the Georgian Soviet Socialist Republic, Union of Soviet Socialist Republics, formed in 1922. It abuts the North Ossetian Autonomous Soviet Socialist Republic on the north, but elsewhere is embraced by the Tbilisi region. Situated on the slopes of the main Caucasus Range, the 1,500 sq. mi. of the oblast constitute a rugged, forested land in which the people pasture their cattle on the highlands or in the valleys, according to the season. The cultivation of maize in intermontane basins, the growing of fruits in the temperate zone, and lumbering are other economic pursuits. Although most of the people are of the same Iranian ethnic stock as their North Ossetian neighbors, they distinguish themselves by using the name Tualte. Georgians constitute 27 per cent of the populace, while almost 70 per cent are Ossetians. Stalinir, a small mountain town, is the administrative center of the oblast. Pop. (est. 1954), 120,000. W. S. V.

**SOUTH PASADENA** [pasədi′nə], a residential city in southern California, part of South Pasadena township, situated in Los Angeles Co., contiguous with Los Angeles, of which it is a suburb. Founded in 1870, South Pasadena was incorporated as a city in 1888. It is governed by a council and a city manager. A feature of special interest in the vicinity is a butterfly farm. Transportation is provided by the Pacific Electric, the Southern Pacific, and the Atchison, Topeka and Santa Fe railroads. Local manufactures include scientific instruments, gas valves, fluid pumps, dresses, rubber stamps, radio equipment, drugs, and electric appliances. Pop. 1950, 16,935.

**SOUTH PLAINFIELD,** a residential borough in northeastern New Jersey, situated in Middlesex Co., contiguous with Plainfield, 30 mi. northeast of Trenton, and 27 mi. southwest of New York City. South Plainfield was incorporated as a borough in 1926. It is administered by a mayor and council. Transportation is supplied by the Lehigh Valley Railroad. Pop. 1950, 8,008.

**SOUTH POLE.** *See* Polar Regions; Seasons (*Change of Seasons*).

**SOUTHPORT,** a county and parliamentary borough and a popular vacation and health resort, in Lancashire, England, situated about 18 mi. north of Liverpool on the Irish Sea. Southport, incorporated in 1867, was created a county borough in 1905 and a parliamentary borough in 1918. Among its attractions are a fine beach used for automobile speed tests, a long seaside promenade, a marine park, and botanical gardens. Pop. 1954, 82,980. A. W.

**SOUTH PORTLAND,** a city in southern Maine, on the Atlantic coast, in Cumberland Co., situated on Fore River, opposite Portland, with which it is connected by bridges. Originally a part of Cape Elizabeth, South Portland was set off and incorporated as an independent community in 1895. It shares Portland's transportation facilities. Industrial establishments include shipyards, copper works, rolling mills, a nylon plant, and a wire-stripping plant. Pop. 1950, 21,866.

**SOUTH RIVER,** a borough in northeastern New Jersey, situated in Middlesex Co., on South River, a branch of the Raritan River, 7 mi. southwest of Perth Amboy. In the heart of the sand and clay region of the state, South River is an important center for the production of bricks and ceramic

objects. Other manufactures include clothing and cigars. The Raritan River Railroad furnishes freight service. Founded by Samuel Willett in 1720, the borough was incorporated in 1898. A mayor and council administer the community. Pop. 1950, 11,308.

**SOUTH ST. PAUL,** a city in the eastern portion of Minnesota, in Dakota Co., on the Mississippi River, 4 mi. south of St. Paul. One of the first settlements in the state and originally called Koposia, South St. Paul was incorporated as a city in 1887. A mayor and city council govern the community. An important shipping and wholesale distribution point, the city has rail facilities furnished by eight railroads, only one of which, the Chicago Great Western, provides passenger service. Stockyards and meat-packing plants constitute the chief industrial establishments. Pop. 1950, 15,909.

**SOUTH SALT LAKE,** a town in north central Utah, situated in Salt Lake Co., 3 mi. south of Salt Lake City, of which it is a suburb. The region is rich in natural resources, including silver, copper, zinc, lead, iron ore, natural gas, coal, phosphate, gilsonite, and timber. The local government is the council-manager type. Pop. 1950, 7,704.

**SOUTH SAN FRANCISCO,** an industrial city in western California, in San Mateo Co. It is situated on San Francisco Bay, about 5 mi. south of San Francisco. Founded in 1896, it was incorporated as a city in 1908. The city's chief employers are the steel, shipbuilding, and meat-packing industries and the air lines at the near-by airport. Pop. 1950, 19,351.

**SOUTH SEA BUBBLE,** the name given to a large-scale financial venture in England, which commenced with the formation in 1711 of the South Sea Company, with a monopoly of trade to Spanish America, and ended in financial scandal and disaster for many stockholders. The original South Sea Company was at first unwisely and afterwards dishonestly managed. When in 1713 England received the Asiento, or right to sell slaves in the Spanish possessions in America, this right was handed over to the company, which rapidly became highly successful. In 1720 the company underwrote the English national debt, on a promise of 5 per cent interest from the government. Its shares immediately rose to ten times their value, speculation ran wild, and all sorts of joint-stock companies, lunatic, fraudulent, or merely optimistic, were formed. A government attempt to halt speculation caused a fall in the price of the stock; this was followed by general distrust, and by November 1720 the Bubble had burst, ruining thousands of families. Almost all the wealthy persons in the kingdom had become speculators, and members of the government were found to be involved in the manipulations of the company. As the result of a parliamentary inquiry, John Aislabie, Chancellor of the Exchequer, and several members of Parliament were expelled in 1721, and the estates of the directors were seized and sold. The company was reorganized on a sounder basis and remained in existence until 1807. C. W. D.

**SOUTH SEA ISLANDS.** *See* Melanesia; Micronesia; Oceania; Pacific Islands; Polynesia.

**SOUTH SHIELDS,** a county and parliamentary borough, seaport, and resort in Durham County in northeastern England. The town lies on the North Sea at the south side of the mouth of the River Tyne, 9 mi. east of Newcastle-on-Tyne, and adjacent to the industrial town of Jarrow. A major port of the coal and steel areas, South Shields is famous for shipbuilding. Coal exporting, formerly a major activity, has diminished considerably, while the manufacture of machines and steel goods has increased.

The town is contained within a sharp bend of the Tyne, and the beach resort at Marsden Bay at the end of Hadrian's Wall attracts large numbers of visitors. Originally a Roman station, Ostia Vedra, the town was founded by the prior of Durham convent in 1245; its present name, derived from *shielings,* meaning sheds, attests to its early fishing industry. Pop. 1952, 107,100. B. Su.

**SOUTH SIOUX CITY** [su′], a city in northeast Nebraska, in Dakota Co., situated on the Nebraska-Iowa boundary, on the Missouri River, 85 mi. northwest of Omaha and 2 mi. southwest of Sioux City, Iowa. Founded and incorporated as a city in 1887, South Sioux City is administered by a mayor and city council. The city is a trading center for a farming region. Local industries include an alfalfa dehydrating plant, a furniture factory, a poultry and egg-processing plant, and a creamery. Pop. 1950, 5,557.

**SOUTH VICTORIA LAND.** *See* Victoria Land.

**SOUTHWELL, ROBERT** [sau′thwəl] (c. 1561-1595), English Jesuit priest and poet, was born at Horsham St. Faith's, Norfolk. He was educated at Douay and Rome and, despite Elizabeth's orders expelling Catholic priests from the realm, returned to England in 1586. In 1589 he became chaplain to the Countess of Arundel, and during his chaplaincy he composed several religious tracts, among them his *Epistle of Comfort.* In 1592 he was arrested while on his way to celebrate Mass, cast into prison, tortured, and finally tried and executed at Tyburn on Feb. 21, 1595. Southwell composed many of his poems while in prison, among them *St. Peter's Complaint* (1595), *Maeoniae* (1595), and *A Foure fould Meditation of the foure last things* (1606). The *Meditation* contains his best-known poem, *The Burning Babe,* of which Ben Jonson is quoted as having said, "So he had written that piece of Southwell's, *The Burning Babe,* he would have been content to destroy many of his." C. D.

**SOUTH-WEST AFRICA,** a mandated territory of the Union of South Africa, formerly a German colony. Facing the South Atlantic between the Cunene River in the north and the Orange River in the south, it is bounded on the north by Angola and Northern Rhodesia, on the east by Bechuanaland, and on the southeast and south by the Union of South Africa. The area of the territory is 317,725 sq. mile; the enclave of Walvis Bay (374 sq. mi.), which belongs to Cape of Good Hope province, is administered as an integral part of South-West Africa.

**Geographical Characteristics.** The distance from north to south is about 800 mi. and from west to east, about 400 mi. A narrow panhandle known as the Caprivi Concession extends nearly 300 mi. due east from the northeast corner of the territory. Acquired by Germany in 1893, this strip gives South-West Africa contact with the Zambezi River, but the eastern end is so inaccessible from Windhoek, the capital, that it has to be administered from Praetoria, Union of South Africa.

Nearly all the territory is about 4,000 ft. above sea level, a vast plateau divided by broken and ragged ranges 60 to 100 mi. inland which extend almost the whole length of the

territory. Some crests are over 8,000 ft. high. West of these ranges is a coastal belt of sterile sand dunes, the Namib Desert, extending from the Orange River to beyond the Ugab River north of Walvis Bay. In the southern part of the territory, drainage is south toward the Orange, the intermittent rivers following highland valleys. Farther north, short seasonal rivers to the west of the highlands flow into the Atlantic; those to the east eventually lose themselves in the Kalahari Desert of Bechuanaland. The only perennial rivers are those forming parts of the boundary of the mandate—the Zambezi, Cuando, Okovanggo, and Cunene in the north, and the Orange in the south.

*Climate.* A line along the highlands from the Orange to the Cunene separates the western region of winter rains from the eastern summer rains. Annual precipitation varies with latitude from about 6 in. along the Orange to about 25 in. in the northeast. Along the southern part of the coast the rainfall is sometimes under 1 in., and this, coupled with the sterility of the soil, creates the coastal Namib Desert. Although neither of these conditions prevails in the highlands or farther east, the increasing heat of inland summers, and the fact that in the east the rainfall comes in the summer months, results in greater evaporation. In fact, except in the north, the Kalahari Desert stretches from Bechuanaland into the eastern section of South-West Africa.

**Population.** According to the census of 1951, the total population was 414,601, including about 48,000 Europeans. Windhoeck in the central highlands, the capital and largest city, had about 29,000 inhabitants in 1951, about 11,000 of whom were Europeans. Because of greater rainfall and heavier vegetation in the far north, there is a greater density of population in that region. The Ovampo, those of Kaffir race and Bantu speech in this area, number about 190,000. They are agriculturalists as well as herdsmen. To the northeast, including the Caprivi Concession, about 15,000 primitive bushmen live wholly by hunting. To the south of the Ovampo are the Damara, a group of people which includes the Hill Damara or Berg Damara and the Herero. The Hill Damara, numbering about 30,000, are of Kaffir stock with some admixture of Hottentot, but their speech is predominantly Hottentot. Scattered widely along the coastal side of the highlands the Herero number about 28,000, speak a Bantu dialect, and are of Negro origin. To the south the predominant racial group is the Hottentot. Although of purer blood than the Hottentot of the Cape, they are obviously of mixed European, Kaffir, and basic Hottentot origin. Their total number is thought to be about 40,000. Finally, there are about 5,000 Griqua or Bastards, of extremely mixed antecedents, centered in the Rehoboth district south of Windhoek. About half the residents of European stock live in towns along the railway, and more than half speak Afrikaans.

*This grotesquely shaped, rock-hard hill in the wilds of South-West Africa is built by great masses of termites.*

PHOTO. CAROLA

**Government.** The administrator of South-West Africa is appointed by and responsible to the Union government. There is a legislative assembly, consisting of 18 members elected by the registered voters of the territory. An executive committee is composed of the administrator and 4 other members chosen from the legislative assembly. In 1949 the status of South-West Africa was changed, when the territory was given the right to elect 6 representatives to South Africa's House of Assembly and to have 4 senators in the Union Senate. Since the United Nations in 1946 refused to accede to the Union's request that the mandate be fully integrated with the Union, the Union has in turn refused to admit the right of the United Nations to make the mandate a trust territory under the UN Trusteeship Council.

There is a chief native commissioner under whom 17 district commissioners operate in administering local government.

**Finance.** The currency is the Union pound, which is at par with the British pound. In September 1949 it was devalued from $ (U.S.)4.03 to $2.80. Revenues in the fiscal year 1953-1954 amounted to £5,750,000 and expenditures to £5,746,000.

**Education.** The government runs only a few schools for native children; however, state aid is extended to most of the 268 schools operated by missions and other agencies. In 1951-1952 government expenditures for education were £629,515, including £496,263 for European children and £133,252 for African children and those of mixed race.

**Economic Activities.** *Livestock.* Karakul sheep, cattle, and goats are the principal kinds of livestock, possession of which is the chief sign of wealth among the native peoples. Except where conditions are favorable to crops, farms in such a dry country are naturally of great size, varying from 12,000 to 50,000 acres. Practically all the crops are either for stock feed or for local human consumption.

*Mining.* Diamonds, copper, and lead are the most important minerals. Diamonds, first discovered to the north of the Orange in 1908, have been found in alluvial deposits along the coast for about 300 mi. They are mostly of gem quality, but decrease in size toward the north. Lüderitz is the chief diamond center. Copper and lead occur mainly in the north in the Grootfontein region and particularly at Tsumeb. In 1952, diamond production was valued at £10,500,000, lead-copper concentrates at £7,800,000, and zinc and lead-vanadium concentrates at much smaller amounts. Other less important mineral products include tin, salt, and semi-precious stones.

**Commerce.** More than half of the imports come from

the provinces of the Union, but less than one third of the exports go to the provinces. The total value of imports in 1953 was £24,069,726, and of exports, £35,178,261. Imports cover a wide variety of goods, especially manufactures. In 1952 the value of exported karakul skins was £5,641,198; diamonds, £10,688,783; and live animals for slaughter, £2,982,000. Lesser amounts of lead, copper, butter, and fish were also exported. Such manufacturing as exists is largely animal food processing (butter and cheese) at Windhoek, Walvis Bay, and Lüderitz. The territory has had a customs union with South Africa since 1915, and receives a prorated share of the combined customs revenue.

*Transportation.* The railway system is an integral part of the government-owned South African Railways. Within the territory are 1,529 mi. of broad-gauge track, 350 mi. of narrow-gauge track, and 3,283 mi. of railway-operated motor services. Consequently, there are not only railroad connections among the major economic sections of the country but also overland routes to Angola and Bechuanaland. Windhoek is connected with both Kimberley and Capetown by air services. Walvis Bay is the most important port, handling about 95 per cent of the territory's foreign exports and a substantial part of the coastal trade. It is 710 mi. by sea from Capetown, but 1,383 mi. by rail.

**History.** In 1486 Bartholomeu Dias put in at the port now known as Lüderitz, which he named Angra Pequena. However, for four centuries neither the Portuguese nor later arrivals found a use for this inhospitable shore. German Protestant missionaries began work in the territory in 1805, working their way north from the Orange River. Great Britain annexed some of the coastal islands in the 1860's and the Walvis Bay area in 1878. In 1883 a Bremen merchant, F. A. C. Lüderitz, purchased land in the vicinity of Angra Pequena from a local chief. The territory so acquired was annexed by Germany in the following year, and in 1885 it was granted to a German colonization society. An expensive war with the Hottentots ensued, and the company was happy to relinquish its claim in 1892. By the following year the Hottentots were pacified. Also in 1893, Caprivi, the German chancellor, negotiated a boundary extension, including the Caprivi Concession, which gave access to the Zambezi River and cut off Southern Rhodesia from contact with Angola. In 1904 a long and bitter struggle began between the Germans and the Herero. By 1908 this Bantu nation was decisively beaten and its tribal system largely obliterated. In the same year, diamonds were discovered just to the north of the Orange River.

Attacked by Union forces at the outbreak of World War I, the Germans surrendered in 1915, and at the end of the war German Southwest Africa was assigned to the Union under a mandate of the League of Nations. In 1925 the Legislative Assembly was established.

After World War II, the Union of South Africa proposed to the UN General Assembly that South-West Africa be incorporated into the Union, arguing that the territory bordered on the Union, that it was economically unable to support itself, that it was sparsely populated, and that a majority of its inhabitants desired incorporation. The General Assembly, however, recommended that the territory be placed under the United Nation's international trusteeship system. Refusing to take this step, South Africa discontinued making reports to the United Nations on its administration of the mandate and in 1949 passed legislation giving South-West Africa representation in the Union Parliament similar to that of a province. The General Assembly then asked the International Court of Justice for an advisory opinion on the territory's legal status. In July 1950 the court issued an opinion with four main conclusions: that South Africa is not obliged to place the territory under trusteeship; that the territory is still under mandate; that the Union is still bound by the mandate's provisions, including the obligation to submit reports on administration; and that the Union cannot change the territory's status without United Nation consent. Despite this opinion, the issue remained deadlocked. W. M. W.

PHOTO-CAROLA

*Laundresses of the Herero tribe of Southwest Africa wear quaint printed calico gowns and carry their flat-irons on their heads.*

**SOUTHWESTERN AT MEMPHIS,** an accredited, coeducational, Presbyterian college of arts and sciences occupying 117 acres in residential Memphis, Tenn. Established by the Masonic Grand Lodge of Tennessee as Montgomery Masonic College at Clarksville in 1848, it was transferred to the control of the Presbyterian Church in 1855 and the name was changed to Stewart College. Twenty years later the name was changed to Southwestern Presbyterian University. After the college moved to Memphis in 1925 the present name was adopted.

The degrees offered are the A.B., the B.S., and the B.Mus. The courses in music are given under co-operative arrangements with the Memphis College of Music. Scholarships, work opportunities, and student loans are available. Residence halls are provided for men and women. *For statistics see* COLLEGES AND UNIVERSITIES. J. R. To.

**SOUTHWESTERN COLLEGE,** an accredited, coeducational, privately controlled institution of arts and sciences affiliated with the Central Kansas Conference of the Methodist Church. It is located on a 36-acre campus in Winfield, Kan. The college was founded in 1885 and first instruction was given in 1886. The degrees offered are the A.B. and the B.Mus. A generous undergraduate scholarship program

is in effect, with no residence restrictions. A student loan fund is available. There is also some opportunity for self-help. Residence halls are provided for men and women. *For statistics see* COLLEGES AND UNIVERSITIES. J. R. To.

**SOUTHWESTERN LOUISIANA INSTITUTE,** an accredited, coeducational, state-controlled college of arts and sciences, teachers college, and technological school occupying 600 acres in the city of Lafayette, La. It was established as the Southwestern Louisiana Industrial Institute in 1898 and opened for instruction in 1901. College rank was attained in 1918, and the name was changed to the present form in 1921. The teacher-training department, founded in 1912, developed into a four-year teachers college, under the name of the College of Education, in 1918. The College of Agriculture was founded in 1938 and the College of Engineering in 1939. The Industrial Arts Department and the Vocational Agriculture Department were established in 1946.

The degrees offered include the A.B., the B.S., the B.S. in engineering and in agriculture, and the A.B. and the B.S. in education. Scholarships are awarded in varying amounts, on the basis of work, honor, or legislative grants. There is also a loan fund. Students from outside the city must live in dormitories, with close relatives, or in approved houses. *For statistics see* COLLEGES AND UNIVERSITIES. J. R. To.

**SOUTHWESTERN UNIVERSITY,** an accredited, coeducational institution of arts, sciences, and fine arts controlled by the Methodist Church, at Georgetown, Tex. It was started in 1873 as an amalgamation of four institutions: Ruterville College (1840), Wesleyan College (1844), McKenzie College (1848), and Soule University (1856). It merged with Blinn Memorial College in 1932. In addition to the College of Arts and Sciences and the College of Fine Arts at Georgetown, the university operates junior colleges at Tehuacana and Weatherford and the Daniel Baker College at Brownwood. The university occupies a total of 645 acres of land. The degrees offered include the A.B., the B.S., the B.B.A., the B.F.A., and the M.A.

Students from outside the city must live in dormitories or in approved houses. Fraternity members may live in their houses; the sororities do not provide living accommodations for their members. Scholarship and student loan aid is generous. Opportunities for self-help enable many of the students to earn part of their expenses. *For statistics see* COLLEGES AND UNIVERSITIES. J. R. To.

**SOUTH WILLIAMSPORT,** a borough in north central Pennsylvania, situated in Lycoming Co., on the south bank of the west branch of the Susquehanna River, opposite Williamsport, 67 mi. north of Harrisburg. The borough is administered by a mayor and city council. The borough was formed from a combination of two previous settlements, Bootstown and Rocktown. Transportation is supplied by the Pennsylvania Railroad. Pop. 1950, 6,364.

**SOUTINE, CHAIM** [su'ti'n] (1894-1943), French painter, was born in 1894 in Smilovitchi, a city in a portion of Russia that was later to become Lithuania. At the age of fourteen, he went to Vilna where he studied at the Academy of Fine Arts. In 1911 he took up residence in Paris, studying at the Atelier Cormon and living in extreme poverty in a Montparnasse studio shared with Amedeo Modigliani. The two painters enjoyed for a time the patronage of Borowski and Paul Guillaume, but after the death of Modigliani, Soutine went to the Midi. He painted at Ceret from 1920 to 1923 and later spent two years painting at Cagnes (1925-1926). It was during the 1920's that Soutine came to prominence as one of the exponents of expressionism, and his celebrity persisted through the 1930's, when his work was known especially for its unconventionality, its violence, and its flamboyant coloring. In 1937 he worked at Chartres, living at the château of a collector-friend, and under the influence of less urgent circumstances his painting lost some of its agitated and volcanic quality. Although some of Soutine's work showed a strong Classical influence, he is remembered today chiefly as an expressionist. He finally took refuge at Champigny-sur-Veude, where he died, Aug. 9, 1943. H. Bol.

**SOVIET UNION.** *See* RUSSIA, HISTORY OF; UNION OF SOVIET SOCIALIST REPUBLICS.

**SOW BUG,** a small terrestrial crustacean, belonging to the order Isopoda, which is usually found under logs, boards, stones, and in similar damp places. The habitat of this crustacean and the fact that many of the species roll themselves into a ball when disturbed have led to the names wood louse and pill bug. Sow bugs are found in most regions of the world; their adaptation to a terrestrial environment is so nearly complete that some forms are even encountered in desert areas where few other animals can survive. Some of the species are destructive to seedlings and young plants and are therefore considered pests in greenhouses. The young emerge from the egg in a brood pouch beneath the body of the mother and remain there until they reach a form similar to that of the adult and are able to shift for themselves. They range from less than ⅛ in. to well over an inch in length. F. A. C.

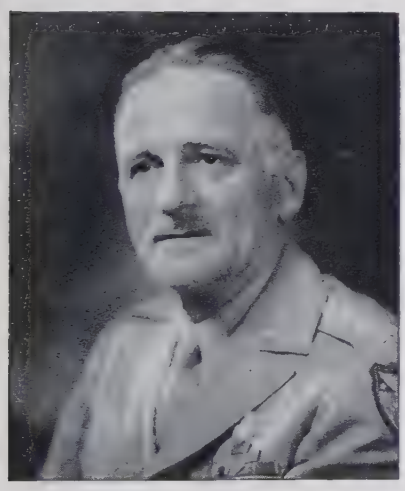
**SOWERBY, LEO** [so'ərbi] (1895- ), American composer and teacher, was born in Grand Rapids, Mich., May 1, 1895. He received the first fellowship at the American Academy in Rome in 1921 and in 1925 became professor of composition at the American Conservatory in Chicago. Two years later he was appointed director of music at St. James's Episcopal Church in that city. Sowerby is a prolific composer and his works have been widely played. His compositions include a symphony, a symphonic poem (*Prairie*), a symphony for organ alone, concertos, chamber music, songs, piano and organ pieces, and sacred choral works. He won the Pulitzer Prize for music in 1946 for his *Canticle of the Sun.* D. L. E.

**SOW THISTLE** [sau'], a genus, *Sonchus,* of coarse annual or perennial herbs of the family Compositae, native to the Old World. Four of the 45 species have become troublesome weeds in North America. These herbs are smooth, leafy-stemmed plants bearing lobed leaves which have prickly margins, and terminal clusters of yellow flower heads, borne in late summer. The achenes bear a pappus of many soft, white bristles. J. C. Wis.

**SOYBEAN,** a common name for *Glycine soja,* an erect annual of the legume family, native to China and Japan. The plant, 2 to 6 ft. in height, bears inconspicuous white or purple flowers and pendent, brownish, hairy pods. It is an important human food crop in the Orient. In Europe and the United States, the plant is grown for forage and soil improvement. The seeds yield valuable products such as oil, flour, and meal. The oil is used in the production of paints, lubricants, soaps, and in many synthetic products. The meal is utilized as stock feed and fertilizer. C. R. Eb.

**SPA** [spɑ′], the oldest and original European spa or watering place, located in a picturesque forested area surrounded by mountains, about 17 mi. southeast of Liège, in east central Belgium. The general term "spa" came into use after the city of Spa in the sixteenth century became famous for its baths and mineral springs and healthy climate. Spa was once fortified and walled, and it is believed to have been occupied in part by the Romans. Several fires, notably in 1644 and 1807, destroyed parts of the town, but it was rebuilt and its casino, bath house, promenades, museum, music halls, libraries, numerous fashionable hotels, and an artificial lake continue to attract from 14,000 to 18,000 visitors annually, chiefly from May to October. Spa reached its zenith of popularity during the eighteenth century when it was patronized by Henry III of France, Charles II of England, Queen Christina of Sweden, and Peter the Great of Russia. During World War I the famous resort was used as a hospital and convalescent center and after March 1918 served as a German headquarters. In July 1920 it was the scene of the Conference of Spa where German disarmament, coal delivery, and war crime trials were discussed by the Allies and German delegates. The only industrial items produced in Spa are lacquer wares and liqueurs, the latter being known as Elixir de Spa. Pop. 1952, 8,943. E. Ma.

**SPAATZ, CARL** [spa′ts] (1891- ), American Air Force officer, was born in Boyertown, Pa., June 28, 1891. He graduated from the United States Military Academy at West Point in 1914, entered the air corps in 1915, and in



CARL SPAATZ

INTERNATIONAL NEWS

1917, during World War I, was sent to France as a major in command of an air squadron. He first trained pilots at Issoudun and later, in 1918, flew combat missions. After the war, Spaatz held various posts in the air force, including the command of the airplane *Question Mark* during its six-day endurance flight in 1929. In 1933 he became chief of training and operations division in the Office of the Chief of Air Corps, and in 1941, a year after he visited England as a special military observer, he was appointed Chief of Air Staff, where he was second in command to Major General Henry H. Arnold. After the outbreak of World War II, he was named commander in chief of the United States Army Air Force in England in July 1942 and in February 1943 became deputy commander of the allied air force in the North African theater. In January 1944, Spaatz was placed in command of the United States Strategic Air Force in Europe and in 1945 assumed a similar post in the Pacific war against Japan. He was appointed commanding general of the United States Army Air Forces in 1946 and retired in 1948. R. T.

**SPACE AND TIME,** terms used in philosophy to describe the structure of nature. They are sometimes conceived as containers in which all natural events and processes occur, and sometimes as relations which connect such events. Space refers to the forms of externality and coexistence; time refers to those of succession and change. Because of the difficulty in conceiving a first or a last instant in time, or an end point in space, both time and space are commonly considered to be infinite in extent. They are usually judged to be homogeneous throughout—space in the sense that there are no hills or hummocks, and time in the sense that it always flows at the same rate. Both space and time are commonly said to be continuous, since they contain no breaks or holes. Opinion differs as to whether they are also continuous in the sense that they are infinitely divisible; certain philosophers, among whom was Zeno, have had great difficulty in conceiving how a finite duration could ever be formed by adding together an infinite number of instants. Space differs from time in at least two ways. Space is three-dimensional while time is one-dimensional. Furthermore, space is indifferent to direction, since the order of right and left, or of up and down, can easily be reversed by adopting a different point of reference; but time seems to have an "arrow" which is fundamental to its nature, since a time which flows backward is essentially inconceivable.

**Historical Controversies.** The two most important historical controversies over space and time are, first, whether empty space is possible, and, second, whether space and time are objective or subjective. The Greek atomists had no difficulty in conceiving unoccupied space and thought it a necessary condition of motion; but Aristotle considered empty space an impossibility. Sir Isaac Newton conceived both space and time after the pattern of absolute containers in which events might or might not occur. Immanuel Kant argued for the subjectivity of space and time, maintaining that they were *a priori* forms of perception, projected by the mind on a world which was not itself in either space or time. F. H. Bradley endeavored to show that the real world cannot be either spatial or temporal since these notions prove to be riddled with contradictions when we try to understand them. Henri Bergson claimed that we can truly grasp the nature of time only when we experience it as pure duration and abandon the scientific technique of analysis by which it is broken up into a series of durationless instants. With the beginning of the twentieth century, theories of space and time became greatly influenced by science. Physics contributed information concerning the way in which space and time are measured, geometry suggested theories of the various types of order, and psychology provided facts with regard to the nature of our perception of space and time. As a result of these discoveries there has been an increasing tendency to think that a philosophical approach to the problems of space and time involves a critical analysis and integration of the information contributed by the more special sciences. *See also* Relativity; Whitehead, Alfred North. A. C. B.

**SPACE PERCEPTION,** the process through which we are aware of the spatial relations of the outside world. The average person does not consider the problems involved, since space seems to be perceived as immediately and easily as any other characteristic of objects, as their color or weight. But we have no sense organs that respond directly to space; it is not a primary sensation like the color red, or the note

middle *C*. Hence, perception of space is very complex, depending on cues obtained from several sense organs.

### TACTUAL SPACE PERCEPTION

**Empirical or Genetic Theory.** Perhaps the simplest type of space perception is seen in the ability to localize a touch on the skin. How can we tell that a fly, for example, is on a spot on our right wrist, rather than the elbow, or the other hand? One of the first answers to the question was given by Lotze in 1852, in his theory of "local signs." He held that each touch spot not only yielded a sensation of touch, like any other touch spot, but also a specific quality, its local sign, which enabled us to tell which particular spot was involved. These local signs had meaning to us only because we had learned to recognize them, during our early life, as we rubbed the skin surface against objects and explored the skin with our fingers. Thus, the local signs became our cues for localizing movements, which would bring the finger into contact with the stimulated spot. This view was an early form of the empirical or genetic theory of space perception, which emphasized the importance of experience or learning in giving us our perception of space.

Perception may be likened to the person who moves into a new house and must learn the significance of various door-bells and buzzers by running to every door when he hears a bell ring. Lotze's theory did not go all the way, however, for he assumed a given or native concept of space itself; we merely learned to localize various objects in space. Later, theorists went further and maintained that even the concept of space is learned through experience and is based on our movements and the resulting sensation.

**Nativistic Theory.** Parallel to this theory was another, the nativistic, which held that we intuitively or instinctively know about space, and that we are able to recognize the point stimulated without any training. Perhaps the most influential exponent of this view was Hering (1861). The theory has generally been less attractive to scientists, for it seems to avoid the problem by saying "We just grow that way." There has been a great deal of experimental work devoted to an attempt to decide between the two theories, but much of it gives no clear-cut answer. It has been shown, for example, that the ability to make accurate tactual localization improves with practice, apparently favoring the empirical theory. But the proponents of the nativistic theory pointed out that the practice may merely have led to more accurate localizing movements; the person may have known exactly where he was touched, even without practice, but he may have missed his aim when he tried to find the spoon with his finger.

**Present Status of Theories.** As a result of many experiments, the weight of scientific opinion swung back and forth between the two theories. The years 1925-1930 marked a strong swing toward the genetic theory, in keeping with a similar trend to deny or minimize the importance of heredity and instincts. But soon thereafter there was an increasing knowledge of the development of the embryonic nervous system, making the nativistic theory more plausible. Observations on prematurely delivered embryos of the rat and guinea pig showed that they could bring up a paw and touch a stimulated spot, although they had had no chance to practice such tactual localization. These observations, and many others, started the pendulum back again, so that the weight of opinion had swung over to the nativistic theory by 1945.

**Existing Data.** The facts that have been gathered in support of the theories are more important than the theories themselves, even in the field of tactual space. We know, for example, that the accuracy of localization varies greatly over the body. It is greatest at the finger tips, and gradually becomes poorer as we go up the wrist and arm to the shoulder. It is extremely difficult to localize a spot on the back, as anyone finds when he tries to touch an itching spot. There is a general rule that accuracy is greatest on the most mobile parts; the lips, for example, are better than the cheeks.

Another way of getting at tactual space perception is the two-point threshold. If two compass points are touched to the skin of the wrist, they are felt as one when they are close together; but if the tips are a half inch apart, they are correctly perceived as two. The minimum distance at which they appear double is called the two-point threshold, and corresponds closely to accuracy of localization. The two-point threshold is only 1 mm. (0.04 in.) on the finger tips, but it may be fifty times as great on the back.

One must not neglect the part played by the kinesthetic (muscle) sense in tactual space perception. It is not enough to know which spot on our wrist is being stimulated; we must also know where in space our wrist is. In the absence of vision, our only cue is the kinesthetic sense.

### VISUAL SPACE PERCEPTION

Much that has been said of tactual space perception also applies to visual space perception. The sensitive part of the eye, called the retina, is a slightly curved surface that lines the back of the eyeball. The light rays reflected from outside objects stimulate this surface, giving sensations of light. But when we ask how we can tell where each spot of light comes from, we have a problem similar to that of tactual localization. Answers have been given in terms of local signs, and of the two traditional theories, empirical and nativistic. But there are additional complications in vision, for visual space perception is a three-dimensional process. It can be broken into two parts, perception of direction and perception of depth.

**Perception of Direction.** Perception of direction is similar in many ways to tactual perception. There is one difference, however, for we do not localize objects at the point of stimulation on the retina, as we do on the skin. Instead we project them along a straight line drawn from the point stimulated, through the lens, and continuing for an indefinite distance. All we can know as a result of a retinal point is the direction of an object; we cannot tell how far away it is. Even this perception requires other cues, for we must know how our eye is directed, how our head is held in relation to our trunk, and how we are standing. All this information comes to us from sense organs in eye muscles, neck and trunk muscles, and the equilibratory mechanism of the inner ear. All these clues are put together in an automatic fashion, so that we can point to an object when we see it, and say: "There it is."

This description applies to the perception of direction of a single point, as a star. But most objects stimulate many retinal points, forming a mosaic pattern. The problems of the interaction of the points which make up such a pattern become quite complicated. There is, for example, a tendency to fill in points that are missing in the image of a known object or a regular figure.

**Depth Perception.** It is not enough to know the direction of an object, for we must know how far away it is before it can be localized in space. Depth cannot be furnished directly by the retina, which is only a surface. The accommodation muscle of the eye which focuses the image gives us one depth cue. Another cue comes from the amount of convergence which is necessary to point the two eyes at

an object. The nearer the object, the greater the convergence, and the greater tension on certain muscles that move the eyes. A more powerful depth cue comes from slight differences in the object as seen by the two eyes. These may be called primary or direct cues. But we also get a great many depth cues from the change in appearance of a known object the further it gets away. The artist uses these secondary cues to give an appearance of depth to his pictures. One of the most powerful is linear perspective. The artist makes parallel lines converge as they recede into the distance. This is really a special case of the general rule that objects cast smaller retinal images as they get further away. Closely related, and based on the same geometrical principle, is the apparently slower motion of distant objects. Another extremely powerful clue is the distribution of shadows. A good portrait photographer utilizes this factor when he makes a long nose seem shorter by directing light in a special direction. In general, distant objects are hazy, because of haze in the atmosphere. Finally, one can be certain that a tree is behind a house if the house hides part of the tree.

It will be seen that all of these secondary cues to depth depend upon knowledge of the object. Hence, we can readily set up unusual conditions that deceive us, leading to illusory perception. A miniature hill, with trees and houses all built to a scale of one to ten, would look like a real hill, but ten times as far away as it actually is. But if the illusion is to work effectively, all conflicting cues must be removed. Binocular cues and the effect of head movement would be most apt to spoil the illusion; they can be eliminated by viewing the scene through a peep-hole. Artists have long recognized this fact, and often examine their paintings monocularly through a tube. This eliminates the binocular clues that make the picture appear flat, and permits the picture to appear in good depth.

**Other Illusions.** Just as the factors involved in depth perception can be clarified by illusions, so can other fields of space perception. There are a large number of geometrical illusions, such as the one in which a pair of parallel lines appear to diverge if they are cross-hatched like the familiar herringbone pattern. A vertical line looks longer than an equal horizontal line, and a bisected line looks shorter than an unbroken one. These illusions and many others must fit into any complete theory of space perception.

Perhaps the most enlightening illusions are those based on orientation to the vertical. Certain amusement parks have "crazy rooms," in which the whole room—floor, walls, and furniture—is tipped up so that the floor makes an angle of perhaps 30 degrees with the horizontal. When we enter this room there is a conflict between our visual perception of the vertical, and our postural-kinesthetic perception. At first, we are dizzy and confused, but we soon become adjusted, and accept a compromise between our two perceptions. Illusions such as this one show that space perception actually involves the co-operation of many different sense organs and muscles, integrated by the brain into an apparently simple pattern; actually a very large part of our body is involved in even the simplest example of space perception.
*See also* SENSATION. H. Sc.

**SPADEFISH,** *Chaetodipterus faber,* a deep bodied fish related to the butterfly fishes, but in the family Ephippidae. The body is much compressed laterally and is approximately circular in outline with an almost vertical forward profile. Color pattern changes from a vertically barred white and black to one that is nearly all white or all black. Spadefish range from Cape Cod to Brazil but are more common toward the south. They are most abundant in bays near rock piles and wrecks where they feed on crustaceans and comb jellies. Spadefish attain a size of 3 ft. and weigh 20 lb. but most specimens average about 1 ft. They are a fine food fish although few are taken commercially along our shores.
E. C. R.

**SPADEFOOT TOAD,** a toad having tubercles on the inner sides of its hind feet with which it digs in sandy soil. *Pelobates* is the European genus, and *Scaphiopus,* the American. Strictly nocturnal, these toads breed in water and are distinct from other toads in that their eyes have vertical instead of horizontal pupils; also, their skins are only slightly tubercular, rather than warty. When seized, they often emit a shrill cry. Some species secrete an offensive substance from the skin. A. Sv.

**SPAIN,** a country in southwestern Europe, occupying about 85 per cent of the Iberian Peninsula. Located between 36° and 43° 45′ N. lat., and 3° 20′ E. long. and 9° 30′ W. long., Spain is bounded on the north by the Bay of Biscay and France, from which it is separated by the Pyrenees Mountains, on the east and south by the Mediterranean Sea and the Atlantic Ocean, and on the west by Portugal and the Atlantic. The Strait of Gibraltar separates it from the northwestern tip of North Africa. Including the Balearic Islands (1,936 sq. mi.) and Canary Islands (2,807 sq. mi.), which in 1927 were incorporated as Spanish provinces, the total area of Spain is 194,945 sq. mi.

## GEOGRAPHICAL FEATURES

**Topography.** The extreme distance from north to south is 540 mi. and from east to west 620 mi. The coast line is over 1,300 mi. long with approximately 700 mi. facing the Mediterranean and 600 mi. the Atlantic and Bay of Biscay. Along the northern coast from the French border west to Cape Ortegal the mountains parallel the sea and there are few indentations large enough to serve as harbors, but along the Atlantic south of Cape Ortegal the mountain spurs reach the sea in a submerged ria type of coast with sheer cliffs, deep harbors, and numerous offshore islands. In this area are the fishing ports of La Coruña and Vigo. In the southwest from the Portuguese border to the Strait of Gibraltar the coast is low and marshy, with Cádiz its only good harbor. From Gibraltar east to Cape Palos the Sierra Nevada descends abruptly to the Mediterranean and there is little or no coastal plain, but north of Cape Palos is a series of narrow coastal plains broken occasionally by mountain spurs. Cartagena, Valencia, and Barcelona are the three major harbors on the Mediterranean.

Physiographically, Spain consists of an ancient crystalline block with alpine mountain ranges of Tertiary period to the northeast and southeast. Between the central block, or Meseta, and the northern range is a tectonic basin through which flows the Ebro River, while between the Meseta and southern mountains is another structural basin occupied by the Guadalquivir River. The Meseta itself is a horst of flat-lying Pre-Cambrian schists and gneisses with granitic intrusions, particularly in the north, and with Paleozoic outcroppings throughout the region. Originally part of the late Paleozoic Hercynian mountain system, this block was folded, faulted, worn down to a peneplane, and partly covered by Tertiary strata, especially in the basins of Old and New Castile. During late Tertiary times the block was again uplifted to an average elevation of about 2,000 ft. with a decided tilt from northeast to southwest. This accounts for the fact that several large rivers originate in the eastern

part of the Meseta and flow westward across it to the Atlantic, instead of turning eastward to the Mediterranean. The Meseta is bounded on all sides by fault scarps and occupies about two thirds of the area of Spain. A number of smaller horsts on the Meseta itself cause local mountain ranges, such as the Sierra de Guadarrama, over 7,000 ft. high, between the basins of Old and New Castile, and the Montes de Toledo to the southwest. In the northeast the Iberian Mountains bordering the Aragon Lowland represent the upturned northern edge of the block and rise locally to about 7,000 ft. In the south the Sierra Morena borders the Andalusian Lowland and is formed by the upturned southern edge of the Meseta. The Cantabrian Mountains in the northwest lie generally in an east-west direction and have been faulted and folded as well as deeply dissected. Elevations reach over 8,000 ft. Young alluvial deposits cover much of Old and New Castile and make these areas between the mountains extremely flat. The only elevations are the long mesas lying as flat terraces above the lowlands. The basin of Old Castile is drained by the eastward flowing Duero, while that of New Castile is drained by the Tajo (Tagus), which also empties into the Atlantic.

*A YOUNG SEGOVIAN SHEPHERD TENDING HIS FLOCK, AT PASTURE IN THE HIGH TABLELAND OF CENTRAL SPAIN*

BURTON HOLMES FROM EWING GALLOWAY

*The Alcantara Bridge, which spans the Tajo River at Toledo, includes masonry of every period of the city's history. Until the thirteenth century it was the only means of approach. The Alcazar, destroyed by fire in 1887 and rebuilt in the 1920's, also played an important part in Toledo's history.*

PHILIP GENDREAU

Northeast of the Meseta, and separated from it by a fault scarp, is the Aragon Lowland, a wedge-shaped depression floored by Tertiary sedimentaries. To the north are the Pyrenees Mountains, to the west and south the uplands of the Meseta, and to the east the coastal Catalan Mountains. The Ebro River rises in the northwest and flows east and south through the depression, eventually cutting its way through the Catalan Mountains to the Mediterranean. Although the river is deeply entrenched, extensive government irrigation projects have been undertaken to make agriculture possible in the arid valley.

The Pyrenees, bordering the north of the Aragon Lowland, extend for about 240 mi. from east to west between the Mediterranean and the Bay of Biscay and form an effective, almost unbroken barrier between the Iberian Peninsula and the rest of the European continent. Folded against the crystalline Meseta during Tertiary times, the mountains rise in several sections to over 10,000 ft., the highest point being Pico de Aneto (11,169 ft.). Extending southwestward from the eastern end of the Pyrenees are the low Catalan Mountains, which were also formed during the Tertiary period. With elevations of from 3,000 to 4,000 ft., they parallel the Mediterranean coast for about 250 mi. and effectively shut off the Aragon Lowland from the sea. A narrow but fertile coastal plain follows the Mediterranean coast north of Cape Palos.

Southeast of the Meseta is the Betic or Andalusian Lowland, a long syncline running northeast from the Gulf of Cádiz. Like the Aragon Lowland the depression was occupied during Tertiary times by an arm of the sea, and the underlying rock is predominantly Tertiary. Much of the floor today, however, is covered by recent alluvial deposits, making the area extremely fertile. The Guadalquivir River flows through the Andalusian depression to empty into the Gulf of Cádiz. Near the delta is an extensive area of marshes known as Las Marismas.

In southeastern Spain is the Penebetic mountain chain, of which the lofty Sierra Nevada is the most famous range. This chain, like the Pyrenees, was folded and uplifted during the Tertiary period. It extends from Gibraltar northeast to Cape Nao, with many of the hills averaging 4,000 to 5,000 ft. in elevation. The Sierra Nevada, however, rises to over 10,000 ft., culminating in Mount Mulhacén (11,420 ft.), the highest peak on the Iberian Peninsula.

**Rivers.** The major rivers of Spain are the Tajo (566 mi. long), Guadiana (515), Duero (485), and Ebro (480). Of these, the first three flow westward to the Atlantic, as does the Guadalquivir (374 mi.) in the Andalusian Lowland and the shorter Miño (171 mi.) in the northwest, while the Ebro and a number of short mountain streams flow eastward to the Mediterranean. Of all the rivers, only the Guadalquivir is navigable for any distance in Spain itself. Seville, 60 mi. upstream, is a thriving seaport. In the case of the other streams navigation is prevented both by lack of sufficient water during much of the year and by numerous waterfalls and rapids. Most of the rivers are entrenched in canyons, making utilization of their water for irrigation a difficult and costly undertaking. The Ebro alone has been developed extensively for this purpose. On the other hand, the use of these rivers for hydroelectric power is hindered by the small amount of water available. Only in the northwest and along the slopes of the Pyrenees is there ample water supply throughout the year, and here considerable hydroelectric development has taken place.

**Minerals.** Spain is richly endowed with mineral wealth. Iron ore is mined in the Cantabrian Mountains near Santander, as well as in the Penebetic Mountains to the south. Coal deposits are found in northern Spain near Oviedo. From Almadén in the Sierra Morena comes approximately one-third of the world's mercury, while the famous Río Tinto copper mines of the southern Sierra Morena have been worked since the end of the thirteenth century. The Linares lead mines, northeast of Córdoba on the southern slopes of the Sierra Morena, have been in production for over 2,000 years. Zinc, silver, manganese, cobalt, potash, and wolfram, although in lesser quantities, are also important to Spain's economy.

**Climate.** The climate of Spain may be subdivided into three types: the temperate marine climate of the northwest and north with moderate temperatures and ample year-round precipitation, the Mediterranean climate of the south and east coasts with mild moist winters and hot dry summers, and the arid continental climate of the interior with its cold winters and warm dry summers. Throughout most of Spain the great determinant factor for agriculture is the water supply. The average annual precipitation varies from over 60 in. in the northwest and on the western slopes of the Pyrenees to less than 10 in. in the Aragon Lowland and La Mancha district of Old Castile. Over half of Spain has an average annual rainfall of less than 20 in. and only about 20 per cent enjoys more than 40 in. per year. Irrigation is necessary along much of the eastern and southeastern coast and in the Aragon Lowland, but the Andalusian depression in the south faces westward to the moisture-bearing winds of the Atlantic so that rainfall here is heavier. Seville has an average annual precipitation of just over 20 in. Over large areas of the Meseta rainfall is inadequate for agriculture, although in the northern part of New Castile enough is received from the Atlantic to permit extensive wheat growing. Madrid has an average annual precipitation of 16 in., but this figure increases appreciably on the higher slopes of the mountains throughout the Meseta.

Temperatures are in general moderate except for areas on the Meseta. In the northwest mean January readings average about 45° F. and August 70° F. At Murcia on the east coast the figures are 50° and 79° respectively. The massive Sierra Nevada protects the southern Mediterranean coast from northern winds, and the climate here is actually of an African type with low humidities and extreme summer heat. It is a region of date palms, bananas, and sugar cane. Winters are cold on the Meseta; severe frosts and even heavy snowstorms are not uncommon. Summers are hot and dusty with the mean temperatures of July and August averaging about 80° F. over much of the area. At Madrid the January mean temperature is 40° F. and in July 77° F. The Andalusian Lowland is, in summer, the hottest part of the country. At Seville the mean August reading is 85° F., and the thermometer may rise in an average year to over 115° F. Winters are mild, with a January mean at Seville of 52° F.

**Soils.** Several types of soil are found in Spain. Covering most of the Meseta are the chestnut-brown soils of semiarid regions. In the south and along the northeastern coast are red Mediterranean soils, while in the southeast are found gray desert soils which are often saline in character. Gray-brown forest soils occur in the deciduous forest areas of northern Spain, and in the coniferous forest belt of the Cantabrian Mountains leached podsol soils are developed.

**Flora and Fauna.** The variety of climatic conditions in Spain, ranging from the more moist and humid northern area to the arid and semi-African regions of the south, has produced a corresponding profusion of different forms of vegetation. Those in the north of the peninsula are representative of the Central European groups, while the various species in the south often reveal African affinities.

At one time Spain was well forested, as indicated by various degenerate forest areas in Murcia, La Mancha, and Granada. At present only 5 per cent of the country's total forest area can be called true forest, and of this one third is pine wood. Deciduous trees are more common in the north, with such Central European species represented as oak, beech, ash, birch, and chestnut. The evergreens are found principally in the arid regions and consist of the Spanish pine, pinaster, and Corsican pine. The oaks are represented by two species: the evergreen oak and the holm oak. In the extremely dry sections of the south, semidesert conditions prevail and the types of vegetation resemble the scrub types found in similar areas of northern Africa. Along the east coast, where there is a much heavier rainfall, a typical Mediterranean floration exists; it is reasonably heavy and contains some semitropical plants and trees, such as citrus fruits.

The fauna of Spain shows the same mixture of European and African types. Among the European forms existing in the peninsula are the Spanish lynx, the Andalusian wildcat, the Spanish wolf, the Spanish fox, and various species of deer, hares, squirrels, and moles. Of special interest among the African types is the Barbary ape of the Rock of Gibraltar. This is the only ape native to the European continent, and it probably came from Africa in comparatively recent times. A species of eagle, the Spanish Imperial, is found both in Spain and North Africa, and the azure-winged magpie of the peninsula has also been discovered in eastern Asia. The genet, the ichneumon, and a certain species of chameleon can be found on both sides of the Strait of Gibraltar. L. M. A.

## ETHNOLOGY AND POPULATION

**Racial Origins.** No simple account can be given of the inhabitants of Spain. Several different racial types appear to have been present in the peninsula since prehistoric times, and a considerable mixing has inevitably taken place. Ancient authorities list the various names of early peoples coming into Spain, but little is known of origins or factual realities behind the names. The best contemporary opinion is that the earliest inhabitants were round-headed, olive-skinned Ligurians about whom practically nothing is known.

At a very early period there was an invasion of long-headed Iberians from North Africa who settled in the east and south. In about 900 B.C., and again in about 600 B.C., there were Celtic invasions from the north; these resulted in a definite Iron Age civilization in the northeast and northwest which had contacts with similar civilizations north of the Pyrenees. On the other hand, the Iberian peoples probably maintained contacts with Africa. It is doubtful if the Greek or Carthaginian settlements had any far-reaching effects on the ethnology of Spain; nor did the Romans contribute any particular racial type to the peninsula. The Arab and Berber invasions from A.D. 711 to 1200 probably resulted in a darkening of skin color in Andalucía which is still discernible. Generally speaking, the inhabitants of modern Spain fall roughly into several racial groups, of which the most clearly marked are a long-headed Iberian type and a round-headed Celtic type.

**Language.** The Spanish language is derived from spoken rather than written Latin, and exists in various dialects such as Andalusian, Galician, and Castilian; this last is considered the purest form of the language. Special mention, however, should be made of Catalan, which is a derivative of medieval Provençal; and Basque, which is unlike any other language found in modern Europe. There is little trace of the ancient Iberian tongues in modern Spanish, and only a comparatively few words are of Arabic or Gothic origin; the Latin influence is predominant. The language itself is musical and flexible; it is rich in idioms, and lends itself to florid and picturesque modes of expression.

**Religion.** The great majority of Spaniards belong to the Roman Catholic Church, although there are small minorities of Protestants and Jews. Catholicism was a state church until the establishment of the Second Republic in 1931, when it was separated from the government. However, following the successful revolt led by General Francisco Franco, the new government re-established formal relations with Rome by a concordat signed June 7, 1942, giving the government the right to nominate to episcopal vacancies.

**Population.** Early estimates of the population of Spain are entirely unreliable, but it is usually assumed that under the Romans and Mohammedans it was considerably larger than in modern Spain. The first reliable census gave a figure of 10,268,150 in 1787; in 1930 the population had reached 23,563,867, and the estimate for 1952 raised it to 28,600,000. The largest provinces are Barcelona, Madrid, and Valencia, the first with over 2,000,000 inhabitants and the last two with over 1,000,000. According to the same estimate, the largest cities are: Madrid, the capital, 1,440,041; Barcelona, 1,268,973; Valencia, 525,630; Seville, 382,564; Zaragoza, 266,684; Málaga, 292,595; Murcia, 215,234; and Bilbao, 230,507. Spain is primarily an agricultural country, and the great majority of its inhabitants live in rural rather than urban areas. It is estimated that fully 70 per cent of the people work on the soil, while the remainder are found in the crafts, professions, and laboring groups.

## GOVERNMENT AND POLITICS

**Central Government.** The regime in Spain since 1939 (the end of the civil war) is officially a monarchy. The chief of state, popularly known as *el caudillo* (leader), is Generalissimo Francisco Franco. He unites in his person full executive, legislative, judicial, and military authority. Although a legislative body known as the Cortes was established on July 17, 1942, it is seldom summoned and meets only to approve Franco's decrees if he submits them for approval. It is not a popular body since two thirds of the members are appointed by the *caudillo* and one third is elected by labor-employer groups known as national syndicates. To assist the chief of state in his executive functions, there is a cabinet of twelve ministers who supervise such departments as foreign affairs, finance, war, and so forth. This cabinet is not responsible to the legislature, but only to the *caudillo.*

The judicial powers of the government are exercised through the Ministry of Justice and the system of courts. However, since the end of the civil war, political crimes have made up much of the business of the judiciary, and special laws and courts have been set up to meet this situation. The Law of Political Responsibilities, enacted on Feb. 9, 1939, defines seventeen categories of crimes against the state, ranging from direct action against the government to the vague charge of "acts contributing to the anarchy prevailing before the Nationalist Movement." This law is enforced by the regular courts, by courts martial (since Spain is technically still under martial law), and a Special Tribunal for the Repression of Masonry and Communism. To obtain evidence, the government relies on the regular police, *Dirección General de Seguridad,* the state secret police, *Guardia Civil,* and the Falange secret police.

**Civil Rights.** As in most totalitarian states, civil rights are rigidly restricted, though they were theoretically granted in 1945 by the law *Fuero de los Españoles.* Freedom of press and speech do not exist; an effective censorship supervises stage and screen production, and all publications, indicating what the government will permit the public to read, see, or hear. Discussion of certain topics, such as governmental reform, or a monarchist restoration, are strictly forbidden. Academic freedom in the universities is likewise restricted; the subjects taught are supervised, as are the professors, while courses in political indoctrination are required for all students.

**Political Situation.** The only political party in Spain is *La Falange Española,* and its chief is Generalissimo Franco. Under him, the party is governed by a national council, a political committee, and various regional representatives. It has its own police, worker-employer syndicates, and youth organizations. There is also a philanthropic organization known as *El Auxilio Social.*

**Finance.** Since the civil war of 1936-1939, government finances have been seriously disturbed. Deficit financing, war, and reconstruction costs have kept taxes high without removing inflationary tendencies. The increase in government spending is reflected in the rise of the budget from 7,200,000,000 pesetas in 1940 to 22,745,000,000 pesetas for ordinary and extraordinary expenditures in 1952. The peseta, officially stabilized at 10.95 to the United States dollar in 1945, was worth .0918 cents in United States currency on Jan. 3, 1950.

**Government Enterprises.** The government engages in a program of economic and social legislation. Plans are being carried out for rural electrification, irrigation, and reforestation. The railroads were nationalized in 1941, and tin, copper, aluminum, zinc, manganese, nickel, chromium, and tungsten mines were brought under government aid and control. At the same time, social legislation was drawn up to provide marriage loans, family relief, and the like.

**Armed Forces.** The Spanish army consists of about 400,000 men, making it one of the largest in western Europe. It played a decisive role in the Nationalist victory, and has been greatly favored by Franco, in 1950 receiving a lion's share of the appropriation (31.8 per cent) for national defense. Although the Falange is supposed to be a rival of the army, it is not a serious threat. The army has amicable

UNDERWOOD - STRATTON

*THE ALHAMBRA, THIRTEENTH-CENTURY MOORISH PALACE, OVERLOOKING THE CITY OF GRANADA, SPAIN*

relations with the Church, and at the end of 1950 observers saw nothing to endanger its commanding position in the regime. The navy consisted in 1951 of 6 outdated cruisers, 22 destroyers, 5 submarines, and numerous smaller craft. The air force, an independent service, is divided into an air branch of planes and parachutists and an air infantry for operation of ground installations.

**Colonial Possessions.** The Spanish colonial empire consisted in 1950 of territory in Morocco, the western Sahara, and Spanish Guinea. With the exception of Morocco, which was considered a protectorate, these areas were governed directly from Madrid. Colonial government in the Franco regime was first supervised by the vice-president, then transferred to the Ministry of Foreign Affairs; finally, on Jan. 23, 1942, it was turned over to a directorate-general, directly under Franco.

## ECONOMIC RESOURCES AND ACTIVITIES

**Agriculture.** The backwardness of agriculture is one of Spain's major problems. The situation has been summed up by one Spanish authority in the phrase: "men without land, and land without men." In such northwestern areas as Galicia, León, and Asturias, the individual holdings are very small, the average figure for Galicia being 2.5 acres per family. As one proceeds southward, small holdings disappear and *latifundismo* (the ownership of large landed estates) becomes much more common. Generally, although 70 per cent of the population derives its living from the soil, only about 10 per cent control it. The areas of the great estates under cultivation are worked by a landless proletariat, who receive very low wages and live under the most adverse conditions. Attempts made by the Second Republic to break up large holdings were, for the most part, unsuccessful; and, since the Franco regime came into power through the support of the landowning classes, its approach to the agrarian question has been highly conservative, being confined to rural electrification, irrigation, and reforestation. One of the worst aspects of Spanish agriculture is the large amount of uncultivated land, principally in the center and south. An estimate made just before World War I placed the amount of uncultivated land at more than 13,000,000 acres. While some of this land is bad, most of it could yield an average crop if carefully worked, in the opinion of observers. However, the great landowners have not wished to go to the expense of bringing additional land under cultivation and the land remains uncultivated, in spite of the fact that the national food supply is insufficient.

The principal crops are potatoes, grapes, and wheat. In 1950 the production figures were: 2,800,000 tons of potatoes, 2,411,000 tons of grapes, and 3,382,000 tons of wheat. Because of bad weather, lack of fertilizer, and the generally obsolete techniques employed, recent estimates of agricultural production are still considerably below prewar figures. Because of these shortages, food prices were still rising in 1950. The raising of livestock is an important phase of Spanish agriculture. The Andalusian horse and bull, the

merino sheep, the Pyrenean mule, and the Spanish goat have long been in great demand and are widely raised. In 1918, the total livestock of the country was estimated at 31,000,000 head; in 1948 the estimated figures gave 25,921,303 sheep, 4,221,759 goats, and 2,688,111 swine.

**Mining.** Coal and iron are the bases for important mining industries in Spain. Coal is found in many provinces, of which the most important are Asturias, León, Burgos, Gerona, Ciudad Real, and Seville. In 1950 Spain produced about 11,044,000 tons of coal and nearly 2,500,000 tons of iron ore. The iron and coal industries have profited considerably from the investments of foreign capital. However, the development of new iron and coal resources has been handicapped by poor transportation. Besides these two industries, the mining and working of copper, lead, zinc, mercury, tin, tungsten, silver and gold, bismuth, antimony and sulphur are important. Almost every known mineral can be found in Spain, although some of them exist only in minute deposits.

**Industry.** Generally, because of a very late start, lack of national capital, and the weak state of the Spanish economy, the industrial development of the nation is still greatly below current needs. Iron and steel production are located principally in three areas: Vizcaya, centering in the city of Bilbao; Valencia, centering at Sagunto; and León, concentrated in the city of Ponferrada. Other important industries in modern Spain use large quantities of chemicals in the making of fertilizers, pharmaceutical products, and perfumes, and in wood distillation. Some industries are favored because of the availability of excellent Spanish olive oil. The textile industry is an ancient one, probably dating from Moorish times, and currently is one of the most important in Spain. It specializes in the manufacture of cotton, silk, and wool; its chief center is Barcelona, largely because of the double advantages afforded by a great port and the hydroelectric developments in the Pyrenean valleys.

**Fishing.** Because of Spain's long coast line, sea fishing has become an important occupation. In 1948 there were 1,201 canning factories and the total catch in 1951 approximated 495,000 tons, mostly sardines, tunny fish, and cod.

**Commerce.** Spain's foreign trade was stimulated by World War II. In an effort to keep wolfram, mercury, and other strategic materials out of enemy hands, the Allies bought heavily in the Spanish market. Agreements with Argentina enabled Spain to exchange ores and manufactures for Argentine grain and tobacco. In 1942, the trade balance was favorable for the first time since 1930. However, at the end of the war Allied buying ceased, the supply of foreign exchange needed for purchases abroad was depleted, and some overseas markets were lost because of hostility to the Franco regime, under which Spain was excluded from the United Nations. Although trade agreements had been concluded with Argentina, the Netherlands, and Italy, the trade balance in 1948 was adverse; imports totaled 470,673,000 dollars and exports only 364,056,000. The note issue of the Bank of Spain was raised on Dec. 18, 1950, from 28,000,000,000 to 35,000,000,000 pesetas, and this introduced an inflationary trend which made the commercial outlook even more grave than before.

**Transportation and Communications.** Even before the civil war of 1936-1939, the Spanish railroad system, handicapped by rugged terrain and a weak national economy, was inadequate. After the civil war the new government estimated the cost of repair at $30,000,000, but, even had this sum been immediately available, the outbreak of World War II stopped supplies from abroad and Spanish industry lacked the capacity to furnish the necessary material. Some restoration was made. In 1941 all standard-gauge lines (7,950 mi.) were nationalized. Total rail mileage was 10,920 in 1947. Although there are 80,141 mi. of highways and roads, the highway system is inadequate to meet modern demands. Regularly scheduled air lines operate between the major Spanish cities, as well as between Spain and other countries. Telephone, telegraph, radio, and cable services are all either owned or controlled by the government.

**Labor Restrictions.** The growth of labor unions and confederations of unions was ended by the Nationalist victory in the civil war. As in most totalitarian countries, unions were replaced by vertical syndicates, including both employers and employees, and strictly controlled from the top by *Falange Española.* Strikes and any sort of independent labor activity were forbidden.

## SOCIAL AND CULTURAL ACTIVITIES

**Standard of Living.** The general standard of living in Spain, already low for centuries, has become even more precarious since the end of the civil war of 1936-1939. The backward state of agriculture, the relatively weak industrial system, the inadequate transportation system, and the damage and shortages caused by the civil war have contributed to this situation. Many cities, badly damaged by the fighting during the civil war, were still unrepaired six years after the end of hostilities, and recovery since then has been slow. Although various laws provide social benefits and pensions, their coverage and payments have been inadequate to meet existing economic conditions. Generally, the vast majority of Spaniards suffer from great deficiencies in food, clothing, housing, and the necessary medical supplies and care. While living conditions have been bad in the cities, they have been worse in the rural areas, where famine conditions have barely been averted on occasions.

**Education.** Spanish education has long been controlled by the Catholic clergy. The Second Republic had tried to establish state-controlled schools, but these efforts ceased with the Nationalist victory in 1939. On July 17, 1945, the new regime passed the Law of Primary Education, which reestablished the church in education. It was given full authority for teaching faith and morals, and the right to require a course of religious indoctrination for all teachers before permitting them to teach. Higher education is strictly supervised. Although primary education is free and compulsory, Spain still has one of the highest illiteracy rates in western Europe. However, the nation has not failed to produce leaders in modern European culture. Spain's great cultural traditions have been represented at home and abroad during the twentieth century by such leaders as Ortega y Gasset, Santayana, and Unamuno in philosophy; Iturbi, de Falla, and Casals in music; Ibañez and Lorca, in literature; Altamira and Madariaga in history; and Picasso in art.

## HISTORY

**Ancient Times.** Very little is known about the earliest inhabitants of Spain. Ancient authorities give lists of tribes and peoples, but practically nothing is known beyond the names. About all that can be said is that Spain was first entered by the Cromagnon Man, and that various types of Stone Age culture—some of it of a fairly high order, to judge by the Altamira cave paintings—gradually developed. Then followed the Copper, Bronze, and Iron ages, and the period of the Celtic invasions from the north. The scanty records of these early times suggest that a relatively advanced culture existed in the Andalusian plain, while the areas to the center and north were more backward.

The earliest commercial contacts were with the Phoenicians and Greeks. The former may have established a colony at Cádiz as early as the eleventh century B.C. Certainly they later planted commercial posts around most of the Spanish coast and may have extended their influence inland. In the sixth century B.C., the Phoenicians of Ionia, carrying Greek culture into the western Mediterranean, finally reached the Spanish coast, where they founded the towns of Rhodae (Rosas), Emporium (Ampurias), Hemerosopium, and Maenaca (near Málaga). The Greeks are supposed to have introduced viticulture and olive growing into Spain.

After 535 B.C., Greek influence in the western Mediterranean waned and was replaced by the rising power of Carthage. This city acquired control of the eastern Spanish coast for the purpose of exploiting the silver mines and for commerce. The Carthaginians established military control over certain areas, but did not attempt a conquest of the interior. Probably they interfered very little with the local affairs of the Phoenicians and Greeks. Carthage founded both Barcelona and Cartagena, the latter being the principal military and commercial center until the advent of the Romans.

In the third century B.C., Carthaginian imperialism collided with Roman ambitions and the Punic wars resulted. The Second Punic War, 219-202 B.C., began with a dispute between the two powers over the Spanish city of Saguntum (Sagunto), and ended with the substitution of Roman for Carthaginian power in Spain. The Roman domination which was thus inaugurated was to last six hundred years, and was to be a determining factor of the greatest importance in Spanish history. By 132 B.C. the wars of conquest were ended, and the assimilation of Spain into the empire began. Administratively, the country was divided into several provinces, but the most important civilizing force was the Roman town populated with Roman colonists, including slaves, businessmen, and war veterans. First the cities were Romanized and then the rural areas. Soon Latin replaced the aboriginal tongues, and by the second century A.D., Spain was an integral part of the empire and one of its economic mainstays. It also contributed great men; Lucan, Seneca, Trajan, and Hadrian were Spanish provincials, and Marcus Aurelius also seems to have been of Spanish descent.

Christianity was introduced into Spain in the second century, and by the third century was beginning to organize itself on the basis of the Roman provincial system. Church councils held in A.D. 306, 380, and 400 set up the administrative system of the Spanish Church. During the last years of the empire, Spain suffered the usual complaints: economic decay, heavy taxation, decline in population, and inefficient rule. However, the peninsula was not successfully invaded until A.D. 409, when the Vandals appeared south of the Pyrenees; the Suevi and the Alans followed, and all three tribes occupied considerable areas. However, they were not destined to be permanent settlers, and by 429 most of them had been driven out by the Visigoths, a vigorous Germanic people who had come from the lower Danube River region under the leadership of Alaric, and had invaded Italy and southern France.

**Visigothic Spain.** The new rulers of Spain had entered the country somewhat ambiguously as allies of the Roman emperor. But, in 456, the Visigothic king, Theodoric II, ended this fiction and ruled as an independent sovereign. The expansion of Visigothic control continued, and Euric, who ruled from 466 to 484, had authority over most of Spain as well as France to the Loire River; he was thus the most important ruler of western Europe. Spain was still regarded as a dependency rather than as the center of Visigothic power, and Toulouse, in southern France, continued to be the capital until the sixth century, when a decline in the political power of the kingdom began. The energetic policies of the Frankish king, Clovis, reduced Visigothic France to a small strip around Narbonne, and by the middle of the century the capital was transferred to Toledo in Spain. At the same time the resurgence of Byzantine power under the emperor Justinian resulted in the re-establishment of certain imperial provinces in southeastern Spain. In this critical situation, the succession of the able Leovigild, who ruled the Visigothic kingdom from about 572 to 586, was opportune. He succeeded in maintaining the northern frontier against the Franks, in greatly reducing the Byzantine coastal provinces, and in conquering a few small areas that had never submitted to Visigothic control.

*EURIC, KING OF THE VISIGOTHS*

FROM AN ENGRAVING BY J. CHAPMAN

CULVER SERVICE

Leovigild is generally considered the most powerful of the Visigothic kings. Following his death, a gradual decline set in, due, in part, to certain difficulties inherent in the Visigothic state. The Visigoths were far less numerous than the people they had conquered, and it is doubtful if there was much fusion between Goth and Hispano-Roman. Both peoples used separate law codes and courts, and, in addition, there were differences of religious forms and ceremonies. Although King Recared (586-601) and his court were finally converted to the Spanish form of Catholicism, this came too late to assist in any reconciliation between the groups. Probably the bulk of the population felt little affection for an alien rule. Another fault of the regime was the weakness of the crown; the great nobles could virtually defy the king at their pleasure and were able to prevent the establishment of a hereditary crown. This situation also prevented the development of any effective administration. As economic conditions deteriorated, the small landowners were virtually swept out of existence, and gradually the population fell into two classes: the great nobles with their dependents, and the serfs. Trade and commerce almost ceased to exist. As conditions grew worse, the kings bid for the support of the clergy against the nobility and made great concessions to the power of the church. The Visigothic clergy were generally bigoted and ignorant; their persecutions of the Jews, which were frequent in the seventh century, were probably a factor in the easy Mohammedan triumph which soon followed.

Visigothic culture made few permanent contributions to Spain. It left scarcely any trace on language, art, or architecture. It did develop one of the most important legal compilations of the age, the celebrated *Lex Visigothorum*,

CULVER SERVICE

*BATTLE OF THE SPANIARDS WITH THE MOORS*

FROM A WOOD ENGRAVING

which, under its later name of *Fuero juzgo,* was to have a profound influence on Spanish jurisprudence. Generally, however, in comparison with the preceding Roman period, the Visigothic era can only be described as a period of general cultural decline. Schools had almost entirely disappeared, cities were in decay, and the ancient classical learning was rapidly being replaced by the grossest superstition. The leading scholar of the age, St. Isidore of Seville (c.560-636), revealed a faulty knowledge of Latin and little comprehension of Classical thought.

**Mohammedan Spain.** The last years of Visigothic rule were marked by internal disintegration and chaos. In 710, after a struggle for the throne between Achila, the legitimate heir, and Roderick, the candidate of the nobility, the latter was successful and was crowned. Partisans of the unsuccessful claimant may have called in the Arabs, who, by this time, had reached the Strait of Gibraltar.

The rise of this remarkable people during the seventh century forms one of the outstanding chapters of European history. Following the death of Mohammed in 632, Persia, Syria, Palestine, and Egypt were soon overrun. During the middle of the century, the Berbers, a fierce and warlike people of the North African littoral, were being repeatedly attacked by Arab armies moving westward; by 695 they were conquered, and later became the spearhead of the Mohammedan assault on western Europe. A Berber army under Tariq crossed the strait named for him, and in 711 defeated Roderick in the Battle of Río Barbate. What first may have been intended as a raid, soon turned into conquest. Tariq pressed forward to the capture of Toledo, Roderick disappeared from history, and the Visigothic monarchy collapsed. The advance forces of the victors soon crossed the Pyrenees and descended on the fertile fields of southern France; meanwhile, behind them, Spain was being organized as an emirate under the Mohammedan governor of North Africa. Although the conquest of the Iberian peninsula was complete by 718, except for small Christian remnants in the Pyrenees and Cantabrians, the consolidation of the occupied territory continued throughout the eighth century.

The relation between Mohammedan and Christian was a serious problem. The lands of the Visigothic crown and church were confiscated by the Berbers and Arabs, but many private individuals retained their holdings on payment of a tax. Similarly, while conversion was encouraged, those who wished to remain in the Christian faith were allowed to do so by payment of a fee. Conditions among the Spanish Christians varied widely. Some of the Visigothic nobility made their submission, became Mohammedans, and henceforth were known as *renegados* by the Christians; they even adopted Arabic names. However, it is equally clear that the bulk of the Christian population was never won over to the Arab-Berber regime, and frequent and sometimes bloody revolts in the large cities testified to the failure of assimilation or conciliation.

Internal feuds among the conquerors produced other serious difficulties. Relations between the Berbers and Arabs were embittered by numerous conflicts, and in 740 a Berber revolt in North Africa spread to Spain, where it was finally put down after bloody fighting by an army of Syrian Arabs brought in for the purpose. Fifteen years later, following a dynastic struggle in Syria which resulted in the extinction of the ruling Ommiad family, a young Ommiad named Abd-er-Rahman, who had escaped the slaughter of his relatives, came to Spain and set himself up as emir. With this event, the political situation tended toward stabilization. Succeeding emirs were able to defend the state against pressure from the Franks, except in the region of Barcelona, which became the Spanish March of the Carolingian empire. Revolts still continued among Christians and Berbers until they were subdued during the reign of Abd-er-Rahman III (912-961), one of the outstanding figures of his time. Shortly after his accession, he changed his title from emir to the more splendid one of caliph, thus indicating his increased power and his complete independence of the rest of the Mohammedan empire.

The period of the caliphate, 929-1031, marked the greatest splendor of Mohammedan Spain. The central government was strong, and its supremacy was not only acknowledged by the subject population but by the tiny Christian states which had survived the debacle of 711. The rich agricultural program introduced by the Mohammedans, plus a foreign trade that reached as far east as India and Ceylon, led to development of a civilization of wealth and luxury. Culturally, it was a fusion of Syrian, Persian, and Byzantine elements, unified by the Arabic language and the Mohammedan faith. The total population of Spain may have reached 30,000,000, with cities as large as Seville with 500,000, Granada with 450,000, and Toledo with 200,000. Córdoba, the capital of the caliphate, may have had over 1,000,000 inhabitants, and undoubtedly was one of the most splendid cities of Europe. Contemporaries were dazzled by its beautiful suburbs filled with gardens and palaces, its famous shops, streets, public baths, and magnificent buildings.

During the reign of the learned Hakam II (961-976) most of the wisdom and learning of the Near East were accumulated in his great library. His agents had been dispatched to Baghdad, Cairo, Damascus, Alexandria, and Constantinople for rare and valuable works. Many publications on Greek science and philosophy and Hindu mathematics were trans-

lated into Arabic and thus preserved for future recovery by western Europe. In the field of medicine, optics, and mathematics, the Spanish Mohammedans made notable contributions. In architecture, they were especially famous for their adaptation of Byzantine forms, such as the dome, and for their rich decoration (arabesques) of flat surfaces. Among the especially notable Spanish scholars were Averroës of Córdoba (1126-1198), whose commentaries on Aristotle became, when translated into Latin, the standard authority until the Renaissance; and Maimonides (1135-1204), who was the greatest Jewish scholar of his time.

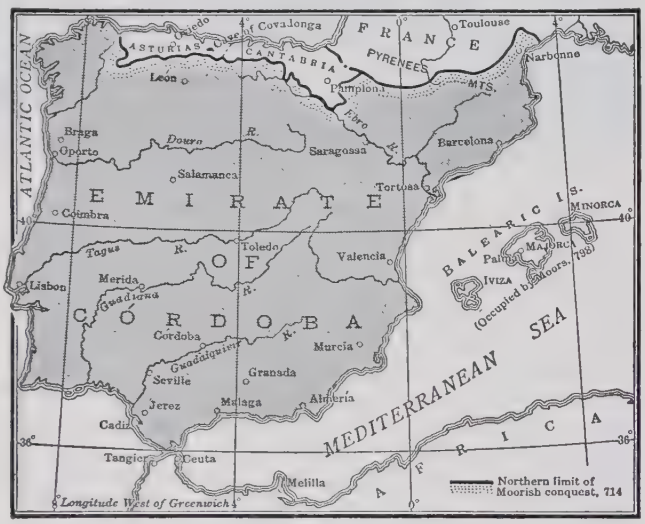
While its culture and material prosperity continued to flourish for several centuries, the political supremacy of Mohammedan Spain did not long survive the caliphate. With the death of al-Mansur in 1002, a period of decline began. Civil war broke out, and in 1031, when the last of the Ommiads was deposed, the caliphate came to an end. It was succeeded by what is sometimes called the *taifa* period (from *taifa,* the Arabic word for tribe or people), when Mohammedan Spain was broken up into several small Arab states or *taifas.* At one time there were as many as twenty-three, although the *taifas* at Seville, Córdoba, Málaga, Granada, Zaragoza, and Badajoz were the most important. This period coincided with the revival of Christian activity in the north, and in its disorganized condition, Spanish Islam was unable to resist the onset of the Christian Reconquest. Furthermore, because of local jealousies, some of the *taifas* allied themselves with Christian neighbors against their coreligionists and thus facilitated Christian recovery.

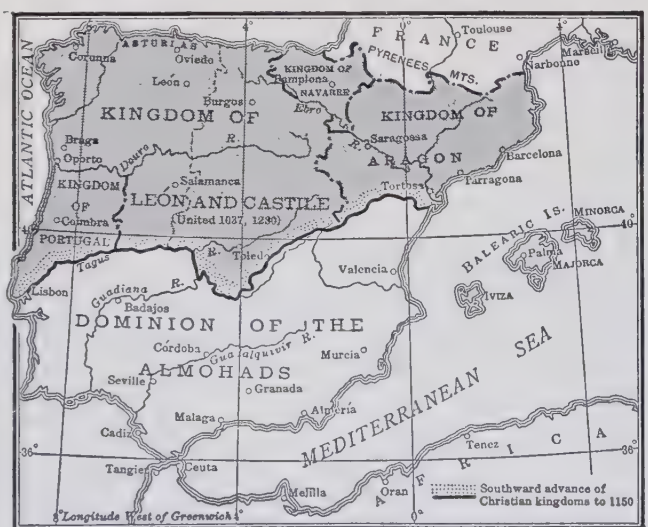
Eventually, the Christian successes led to new invasions from North Africa. In 1085, the fall of Toledo caused some of the *taifa* rulers to invite Yusuf ibn-Tashfin, of the Berber Almoravides, into Spain. He came and inflicted a great defeat on the Christians, but proved unable to accomplish any permanent unification. Following the disintegration of the Almoravide conquests, another Berber tribe known as Almohades invaded Spain in 1147 and reduced the *taifas* again, but, after a defeat by Christian forces in 1212, the Almohade empire also disintegrated and the Spanish Mohammedans were left alone to fend off Christian attacks.

**Reconquest and New Christian Kingdoms.** Following the fall of the Visigothic kingdom, some of the survivors—bishops, nobles, and the remnants of the army—gathered in the Asturian mountains near Oviedo and managed to hold off the victorious Arabs. Because their economic and political interests drew them to the center and south of the peninsula, the Mohammedans tended to withdraw from the extreme northern frontier and thus the tiny kingdom of Asturias not only continued to survive, but, without much opposition, even managed to expand to a somewhat shifting frontier just south of the Duero. In the next two centuries, Navarre and Aragon made their appearance, and the capital of Asturias was moved farther south to León as a base for additional conquests. Charlemagne had brought the northeast corner of Spain under Frankish control, but by 874 Wilfred of Barcelona is supposed to have become independent and thus inaugurated the history of the county of Catalonia.

The tenth century was marked by the establishment of an eastern salient of León, subsequently known from its numerous fortifications as the county of Castile. During the rule of the redoubtable Count Fernán González (930-970) a permanent capital was set up at Burgos, and the autonomy of Castile was recognized by the kings of León. The emergence of this new state was an important development; henceforth, it was to be the most active agent in the recovery of new lands, and eventually was to absorb the parent state of Léon itself. However, as the tenth century drew to a close, it seemed that the future of a united Spain lay with Navarre rather than with Castile.

Navarre was probably founded during the wars between the Franks and Basques; in 1000 it came under the rule of Sancho the Great (970-1035). Taking advantage of the growing weakness of the caliphate, Sancho interfered successfully in the neighboring realms, and by 1029 he had united all the Christian states of the peninsula under his control. However, this union was premature. Navarre was too small to hold so great an expanse, and the spirit of local independence was still too strong. Sancho himself so little understood what he had accomplished that on his death in 1035 he divided his territories among his sons, at the same time raising both Castile and Aragon to the rank of kingdoms. The death of Sancho the Great forms a convenient dividing line in Spanish history. For one thing, it marked the beginning of the independent histories of Aragon and Castile and inaugurated the growing supremacy of the latter over León. In 1037, Sancho's son, Ferdinand I of Castile (1035-1065), overwhelmed León and united the realms which thereafter were separated only briefly. Another im-

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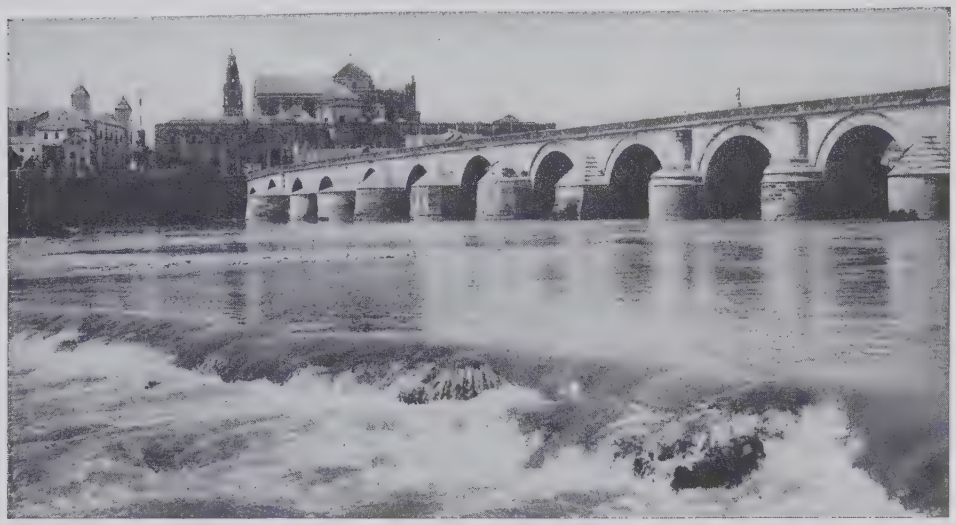
*CONQUEST OF SPAIN BY THE MOORS AND RECONQUEST BY THE CHRISTIANS UP TO 1150 A.D.*

portant change after Sancho's death was the intensification of the Reconquest, vitalized by a growing religious fanaticism.

While, prior to the eleventh century, wars between Mohammedan and Christian states had been frequent, there had also been periods of peace, with considerable intercourse between the followers of the two faiths. During the *taifa* period, Arabs and Christians had often been allies against common enemies. During the reign of Sancho, members of the great monastic order of Cluny began to enter Spain, where they soon won a reputation for piety and religious zeal. The religious revival they introduced expressed itself in an increasing hatred for the infidel. The period of the Spanish crusades had arrived. In addition to religious motives, the increase in population and consequent land shortages probably helped to turn the Christian kings and nobles southward against Spanish Islam.



*MOORISH BRIDGE CROSSING THE GUADALQUIVIR RIVER AT CÓRDOBA*

BURTON HOLMES FROM EWING GALLOWAY

Under Alfonso VI (1065-1109), Castile enjoyed many triumphs. Toledo fell in 1085, Valencia in 1094, after a nine month's siege in which the famed el Cid Campeador commanded the attacking forces. The Almoravide invasion recovered Valencia in 1098, but most of the other conquests held firm. A period of anarchy followed Alfonso's death, marked only by the establishment of the kingdom of Portugal; then, in 1144, Alfonso VII (1109-1157) resumed the offensive and pushed the frontier farther south. His grandson, Alfonso VIII (1158-1214), made additional conquests, and, with the help of León and Navarre, he was able to win the great battle of Las Navas de Tolosa in 1212, from which the Mohammedan military power never recovered. Ferdinand III (1217-1252), better known as San Fernando, practically completed the work of recovery. He captured Córdoba in 1236, Murcia in 1241, and Seville in 1248. Except for a few isolated conquests, the Castilian crusades lapsed until revived by Isabella in the fifteenth century.

Meanwhile, Aragon was expanding, not only along the southeastern coast, but also overseas. The great conquests began in 1118, when Alfonso I captured Zaragoza, and concluded in 1238 with the surrender of Valencia to James the Conqueror. The conquest of Murcia by Castile abruptly limited the southern expansion of Aragon, but James (1213-1276) had already acquired the Balearic Islands during 1229-1235, thus inaugurating Aragonese imperialism in the Mediterranean. James' son, Pedro III (1276-1285), conquered Sicily in 1282, and Sardinia was acquired early in the next century.

The wars of the Reconquest were destined to have a profound effect on the history of Spain. The centuries of fighting an enemy of another faith intensified the religious feelings of the people and helped to develop a fanatical unity of religion and patriotism which was long characteristic of Spain. Furthermore, the vigorous and continued existence of individual states strengthened the tendencies of disunity and separatism already fortified by Spanish geography. Another result was the stimulation of a desire for wealth and power in the Spanish people, which continued well into the colonial period.

**Castile and Aragon.** Since feudal institutions passed from France into all the Spanish kingdoms, the monarchies in both Castile and Aragon developed along feudal lines. Thus the kings were served by vassals, who assisted them in peace and war, and, in return, received lands and favors. Although the kings in theory were supreme, this supremacy was often limited to their own estates; on lands belonging to the church or to the great nobles, the crown was likely to be weak. Wars between the crown and the nobility were frequent. Until the twelfth century, most of the Spanish people consisted of agricultural laborers in varying degrees of enserfment, but during the eleventh century, with the general European trade revival, a definite mercantile class appeared. As in France and England, the rise of this class in Spain was simultaneous with a great increase in the number of towns, and by the end of the twelfth century, in León at least, the townspeople were recognized as a definite order in the state. It had long been the custom for the king to call the nobles and prelates to the court to render advice on important problems. Such a council at Nájera in 1137 was called a cortes, and the name, used thereafter for such gatherings, eventually became the official title, of the national legislative body. At a cortes held in León in 1188, the representatives of towns were admitted for the first time; later, they became the most important element in such meetings. While at first intended as an advisory and petition-making body, the Castilian Cortes eventually obtained important financial powers as well, and, until the middle of the sixteenth century, often showed remarkable independence in dealing with the royal authority. In local affairs, the towns were usually conceded almost complete freedom by the charters, or *fueros,* which the crown bestowed upon them.

While the Castilian crown had its difficulties with its unruly nobility, as long as the frontier existed the kings were

often able to divert the excess energy of ambitious lords in that direction. However, the slackening of the Reconquest after the death of Ferdinand III, plus the weakness of certain later monarchs, produced near anarchy during most of the fourteenth and fifteenth centuries. Alfonso X (1252-1284) was celebrated for his learning, which earned him the nickname *el Sabio* (the Learned), but he was lamentably weak in dealing with the feudality. During the fourteenth century, only Alfonso XI (1312-1350) was able to maintain his royal rights. After his death, civil war and the accession of a new and unstable dynasty in the person of Henry of Trastamara still further strengthened the nobles' position. The reigns of John II (1406-1454) and Henry IV (1454-1474) marked the almost complete abasement of royal power, and the anarchy of the great nobles continued unchecked.

In Aragon, likewise, the end of the Reconquest complicated the position of the monarchy. Royal authority had always been considerably more limited than in Castile, and, through the Aragonese Cortes, the nobility, and especially the merchant class of Catalonia frequently rebuked monarchs who dared to exceed their constitutional privileges. The situation was further complicated by the *justicia* or chief justice, who was actually above the king in judicial matters and frequently acted as mediator between the crown and the nobility. Toward the end of the thirteenth century, the barons of Aragon were able to force the crown to recognize their rights in a document called the *General Privilege.* This was reaffirmed in 1287 by Alfonso III (1285-1291) in the famous *Privileges of the Union,* which gave official recognition to a league of nobles called the Union. A climax was reached during the reign of Pedro IV (1336-1387), who was more than a match for the nobility in craft and violence. Open war broke out, and in 1348, at the battle of Epila, Pedro completely crushed the opposition. The Union was dissolved, and henceforth the tendency was toward absolutism and centralization; nevertheless the *General Privilege* still remained, and royal authority in Aragon never possessed the extensive powers which, in theory at least, were enjoyed by the crown of Castile. A change of dynasty in 1410 brought a branch of the House of Trastamara to the throne of Aragon, thus helping to pave the way for the final union of the two states under Ferdinand and Isabella. The next two kings, Alfonso V (1416-1458) and John II (1458-1479), were far abler than their Castilian contemporaries, John II and Henry IV, and successfully defended the royal prerogatives.

During this period, both monarchies had serious racial minority problems resulting from the presence of large numbers of Jews and Mohammedans. Although there was no clear-cut policy with regard to either, considerable popular opposition to both groups developed during the fifteenth century, with numerous outbreaks of mob violence. There was still some Arabic influence in the arts, literature, and possibly music, but French influences predominated. Gothic architecture was introduced, and Flemish methods in painting may have been brought to Spain by the Van Eycks. As for social conditions, Castile continued to reduce serfdom, but the crown in Aragon was able to do little to improve the condition of the rural masses. In addition to agriculture and trade, grazing became a very important industry. In Castile, the grazers were organized in a powerful guild called the *Mesta,* which frequently won for them favors from the crown that were prejudicial to the rights of the farmers.

**Spain as a Great Power.** The period of anarchy in Castile was ended by the accession of Isabella I (1474-1504). This princess was a daughter of John II by his second wife, and hence a half sister of Henry IV. Carefully brought up by her mother, she was devout, deeply conscious of her responsibilities, as well as able and determined. In 1469, she married Prince Ferdinand of Aragon (1479-1516), her equal in intelligence and probably her superior in craft, but far below her in piety. Although Isabella's rights to the crown of Castile were contested by her half brother, and actively opposed by Portugal, she was generally accepted as queen when Henry IV died in 1474 without male heirs. Portugal's opposition ended in defeat in 1476. The union of the two states was purely a personal one, based on the marriage of the two rulers; neither ruler interfered in the internal affairs of the other kingdom, and except for the Inquisition, there were no institutions common to each.

Isabella's reign in Castile was marked by numerous reforms. To check the depredations of the nobility, the queen reorganized the administration of justice, and in 1476 she established a rural constabulary to put down disorder. By the Act of Resumption in 1480, the nobility were forced to give up lands and pensions improperly obtained from the crown. Restrictions on castle building still further weakened the

*THE ROYAL PALACE, MADRID, BUILT ON THE SITE OF AN OLD MOORISH ALCAZAR*

EWING GALLOWAY

position of the feudal lords. To provide the crown with adequate administrative help, the Council of Castile was reorganized with increased powers and additional personnel from the middle class. This body soon became the principal administrative organ of the state, assisting the crown in virtually all aspects of administration. To insure religious unity, the Holy Inquisition was established in 1478, with special church courts and investigators to suppress heresy. Although administered by the clergy, the Inquisition was directly con-

*Hernández Gonzalo de Córdoba, El Gran Capitán, who negotiated the surrender of Granada for Isabella*

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trolled by the crown; the rigor of its methods, and the severity of its sentences, publicly carried out in the auto-da-fé, soon made it one of the strongest weapons employed by the government. In matters of foreign policy and war, Isabella's greatest achievement was the conquest of the last Mohammedan state of Granada in 1492. As a result of her sponsorship of Christopher Columbus she became the founder of the Spanish colonial empire (*q.v.*).

The situation in Aragon, where opposition to royal power was well entrenched, was less favorable to reforms, and Ferdinand did not attempt many. However, in foreign affairs, his reign was a brilliant success. Not only is he entitled to credit for Castile's successful wars against Portugal and Granada, but he was also responsible for the seizure of Spanish Navarre, the Spanish conquest of Naples, and the complete frustration of French ambitions in southern Italy.

After the death of Isabella in 1504, of Philip I in 1506, and of Ferdinand in 1516, the Spanish crowns of Aragon and Castile went to Charles I (1516-1556), son of Philip I and Isabella's daughter, Juana. In 1519, as Charles V, he was elected Holy Roman Emperor in succession to his grandfather, Maximilian I, and found himself ruler of Spain, Naples and Sicily, the Hapsburg territories in the Low Countries (Belgium and the Netherlands), Austria, and the Spanish colonies in the New World. Spain had become a world power, and Charles was the most powerful sovereign in Europe. During his reign, Spain became deeply involved in questions of little immediate interest to it, although of great importance to Hapsburg *weltmacht*. Consequently, Spanish wealth and Spanish soldiers were used to fight the Lutherans in Germany, the Turks in the Mediterranean, and the French in Italy and the Rhineland. Charles failed to halt the advance of the Turks, and he was unable to prevent the establishment of Lutheranism in Germany. He was more successful in promoting church reforms which culminated in the Council of Trent, 1545-1562. His wars with France began with victories but ended in a stalemate. He made few changes in Spanish administration, and, after the difficulties of the early years of his reign, became popular as a monarch.

On Charles's abdication in 1556, his Austrian holdings went to his brother Ferdinand; however, the greater part of his realms passed to his son Philip II (1556-1598). Philip had been brought up in Spain, and, in spite of his Germanic heritage, was regarded as a true Spaniard. Not so bold as his father, he was cautious and plodding, and was convinced that he was chosen by God to assist in the eventual triumph of Catholicism. However, much of his long reign was marked by failures. His policies in the Low Countries, which resulted in unrest and rebellion, helped to bring about the birth of the Dutch republic. His efforts to bring England into the Hapsburg sphere of influence were equally unsuccessful. Finally, in 1588, goaded into action by the depredations of English seamen on Spanish commerce, and Queen Elizabeth's assistance to the Dutch, he dispatched the famous Spanish Armada in an utterly disastrous attempt to effect a landing on the English coast. His intervention in the French religious wars probably prevented a Huguenot from becoming king of France, but, when Henry IV became a Catholic, Philip was forced to accept the fact and withdraw his armies. He was more fortunate in his acquisition of Portugal in 1580 through inheritance, and in his great naval victory in 1571 over the Turks at Lepanto, which temporarily checked Ottoman naval power.

Internally, Philip kept the same administrative system as his father, with the accent on paternalism and centralization, although frequently his plans suffered from the slowness of Spanish administration. The dreaded Holy Office of the Inquisition continued in power. The Cortes was summoned as

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*SPANISH STATES AND PORTUGAL IN 1492*

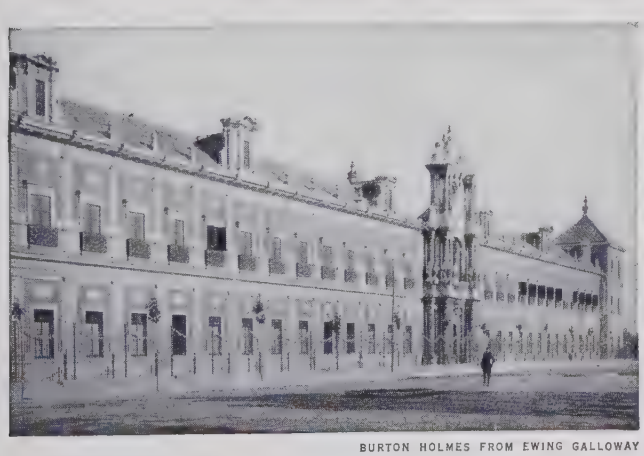
seldom as possible, and during the last decade of Philip's reign the stubborn Aragonese were forced to accept a modification of their celebrated liberties in the interest of increased royal authority. A Mohammedan uprising in 1568-1571 greatly alarmed the government and led the king to adopt a policy of severity in dealing with religious minorities. Henceforth, compulsory conversions were the order of the day.

**Decline of Spanish Power.** Although Spain was still considered a great power after the death of Philip II, internally a serious decline had already set in. The fact was that the international ambitions and commitments of the House

of Hapsburg had strained the resources of the country to the breaking point. Although the revenues of the kingdom, augmented by the income from the colonies, were enormous by sixteenth century standards, Charles V left huge debts, and Philip II was forced into bankruptcy in 1557, and again in 1575. By the end of his reign, taxation was ruinous and the government was still unable to balance expenditures with income. Furthermore, business conditions suffered from an adverse trade balance and the unwise financial policies of the government. The tremendous influx of bullion from the New World had the effect of raising prices in Spain considerably above the general European level, so that while Spain was a good country to sell to but it was a poor one from which to buy. One of the principal sources of government income, a sales tax of 10 per cent, also helped to complete the ruin of the domestic economy. As a result, the rapid decline of almost every sort of production made it increasingly difficult for the state to meet its commitments as a world power.

The reigns of Philip III (1598-1621) and Philip IV (1621-1665) failed to improve these conditions. The former made peace with England in 1604 and signed a twelve-year truce with the Dutch in 1609, but, in spite of peace, he continued to spend large sums on his favorites and on amusements. In 1618, a dispute broke out between Emperor Ferdinand II and the Bohemian Protestants which marked the beginning of the conflict known as the Thirty Years War (1618-1648). Spain entered the struggle because of a desire to help the Austrian Hapsburgs, advance the Catholic faith, and recover, if possible, the Dutch provinces. Philip III died in 1621, but his policies were continued under his son Philip IV. At first, Spain had some successes under its great general, Ambrogio di Spinola, but after 1630 met nothing but disaster. Both Portugal and Catalonia revolted in 1640, and, in order to reduce the Catalan rebels, the Portuguese were neglected and were able to recover their independence. In 1648 there was a general peace, although Spain continued to fight France unsuccessfully until the Peace of the Pyrenees in 1659.

The only bright spot in the general decay was in literature and the arts. During the sixteenth and most of the seventeenth century, the intellectual life of the nation flourished. Salamanca and Alcalá were still recognized as leading European universities. El Greco (c.1548-c.1625), Velázquez (1599-1660), and Murillo (1617-1682) revealed the glory of the Spanish school in painting and were among the great European artists. Literature produced the incomparable Cervantes (1547-1616), whose novel *Don Quixote* is the common possession of all Western nations. In drama, the plays of Lope de Vega (1562-1635) and Calderón (1600-1681) were enormously popular, and, translated into French and German, influenced a great number of European dramatists.



BURTON HOLMES FROM EWING GALLOWAY

*The Palacio de San Telmo at Seville dates from the seventeenth century when it was used as a naval college. It is now a theological seminary.*

The reign of the sickly and neurotic Charles II (1665-1700) completed the decline of the Hapsburg rule of Spain. Following his death without heirs, the crown went to a Bourbon French prince, Philip, duke of Anjou, grandson of Louis XIV, and great grandson of Philip III. In spite of the War of the Spanish Succession, in which France and Spain opposed England, the Netherlands, and the Holy Roman Emperor, Philip V (1700-1746) maintained his throne with only the loss of the southern Netherlands, Gilbraltar, Naples, and Sicily. The accession of the Bourbon dynasty (1700-1931) brought some improvement; a less grandiose foreign policy was followed, and great efforts were made by the crown to improve economic conditions. Both Ferdinand VI (1746-1759) and Charles III (1759-1788), the ablest kings of the century, were also successful in preventing further losses to the empire both in Europe and overseas. As a consequence of Spain's support, France, by a secret treaty in 1763, transferred the vast Louisiana Territory in North America to Spain. Forty years later the territory, after having been retroceded to France in 1800, was sold by Napoleon to the United States.

**Further Decline.** The foolish and incompetent Charles IV (1788-1808) was completely helpless in the face of the great problems created by the French Revolution. Although Spain in 1793 joined the other European powers in war with France, it was forced to make peace two years later, and henceforth was definitely within the French orbit. Napoleon used Spain as a pawn in his wars against England and in his plans for conquering Portugal. However, finding King Charles slow to comply with his demands, he forced him to abdicate in 1808 and awarded the crown of Spain to his brother Joseph. Joseph's reign was short. Napoleon's military occupation of Spain and his attempt to force a monarch on the people provoked a popular uprising. Aided by Spanish guerrilla forces, British troops under Sir Arthur Wellesley, later the Duke of Wellington, defeated the French in a series of bloody engagements, and by 1813 had driven them from the peninsula.

After the fall of Napoleon, Charles's son, Ferdinand VII (1814-1833), was recognized as king, and it seemed that a new era was about to dawn. However, Ferdinand VII was violently opposed to the trends in Spain since 1789. A liberal, although somewhat impractical constitution, had been drawn up in 1812 by the Spanish leaders opposing King Joseph. Ferdinand had accepted it before returning to Spain, but once assured of his crown he violated his promise and directed a violent reaction against all liberal elements. An effort to force him to accept the constitution of 1812 failed when France intervened in 1823 to re-establish him in absolute power.

The remainder of the nineteenth century in Spain was a dreary chronicle of intrigue, chaos, and the failure of reform. Following the death of King Ferdinand in 1833, the succession of his daughter Isabella II was contested by her uncle Don Carlos, provoking the Carlist civil wars from 1833 to 1839. The final success of the queen failed to produce any improvement, for she proved to be completely devoid of responsibility or moral sense. Until her expulsion from Spain in 1868, the government was largely controlled by military cliques. Following her dethronement, the crown

was offered to Amedeo of Savoy, son of Victor Emmanuel II of Italy, but, as King Amadeus I, he soon found the situation completely impossible and abdicated in 1873. A brief and unhappy republican interlude, 1873-1874, convinced the army that only a restoration of the monarchy could put an end to domestic strife, and, consequently, on Christmas Eve of 1874, General Martínez de Campos proclaimed the son of Isabella king, as Alfonso XII. The republic collapsed.

ALFONSO XIII, KING OF SPAIN

CULVER SERVICE

Alfonso (1874-1885) proved a satisfactory if uninspiring monarch. A regime of pseudo-constitutional government was introduced with the Constitution of 1876, which appeared to provide the machinery for a more democratic government. However, such a system was incompatible with the backward masses of the Spanish people. Actually, elections were manipulated by the Home Office to produce any result desired by the coalition of nobility, church, and army, which was actually controlling Spain; an understanding between the leading politicians assured a constant rotation of Liberal and Conservative prime ministers. Alfonso's death failed to produce any crisis in the succession, since the queen soon gave birth to a son who was to become Alfonso XIII (1886-1931). Until 1902, the queen acted as regent.

Although the government was reactionary and corrupt, conditions in nineteenth century Spain were not entirely stagnant. Actually, important changes were slowly taking place beneath the surface. Largely sponsored by foreign capital, the industrial revolution was making a belated appearance in Catalonia and Asturias. The failure of the government to improve conditions affecting the peasants and workers led to the growth of protest movements. The Socialist Party was founded by Pablo Iglesias in Madrid in 1879; the Anarchists had already established themselves in Barcelona. In 1888, the Socialists founded a general trade union known as the U.G.T. *(Unión General de Trabajadores),* and in 1910 the Anarchists sponsored the C.N.T. *(Confederación Nacional del Trabajo),* which was somewhat similar. Although the U.G.T. tended toward legal constitutional methods, while the C.N.T. often resorted to violence, both groups used the strike technique. During the latter part of the nineteenth century, the Anarchists acquired a foothold in the countryside, especially in Andalucía. Meanwhile, two ancient institutions, the crown and the church, declined considerably in prestige, the latter especially losing ground in popular support. Another important development resulted from the Spanish-American War in 1898, and the loss of the last Spanish colonies. Important writers, such as Pío Baroja, Ángel Ganivet, Joaquín Costa, and Ortega y Gasset, were shocked into activity by this defeat and began a searching criticism of Spanish institutions and politics.

**End of Monarchy.** No great changes marked the accession of Alfonso XIII, although the king showed a definite tendency to interfere in politics. During World War I, Spain's neutrality proved profitable, and the middle and upper classes were greatly enriched. However, a depression set in after the war and discontent grew. Following a military disaster in Spanish Morocco in 1922, which was attributed to a blunder by the king, a dictatorship was established by General Primo de Rivera. Undoubtedly this saved the monarch from a personal humiliation. From 1922 to 1929, Rivera, with royal support, governed the country and was able to accomplish a few reforms. However, his regime was increasingly unpopular, and in 1929 he was finally dismissed by the king. For fifteen months Alfonso fought to preserve his throne, but one by one his most important supporters left him. Following local elections in which all but four provincial capitals elected Republican candidates, the army and the Civil Guard withdrew their support of the crown, and on Apr. 14, 1931, Alfonso XIII, without abdicating, left the country.

**Second Republic.** The Spanish Second Republic had a checkered history from 1931 to 1939. A Republican-Socialist coalition controlled the government for two years and attempted numerous reforms in education, religious affairs, finances, and agriculture. Autonomy statutes were drafted for Catalonia and the Basque provinces. However, failure to solve the agrarian problem lost the government its peasant support, and its religious policy alienated many of the upper classes. Attacked by both Left and Right, it was defeated in the 1933 elections and was succeeded by a conservative coalition of Right parties under Gil Robles. This group, in turn, was defeated because of its reactionary policies and its bloody suppression of a revolt in Asturias in 1934. In 1935, moderate and Left parties formed the Popular Front which drove the conservatives out of office in the elections of February 1936.

**Civil War.** During the next few months Spain seemed about to dissolve into chaos as gunmen of both the extreme Left and Right shot it out in the streets. On July 17, 1936, civil war began as a group of generals led by Francisco Franco, Emilio Mola, Sanjurjo, and others started revolts against the government in various cities and in Spanish Morocco. From the beginning, the rebels were supported by large elements of the clergy, nobility, and army, as well as the various Spanish fascist parties. In addition, they quickly received large supplies of materials and men from Germany and Italy, which suggests that they had received promises of foreign support in advance of the uprising.

The civil war lasted about three years, and large areas of the country were devastated. The struggle assumed an international character as men of almost every nationality came to Spain to take part in the struggle for or against fascism. However, because of the efforts of England and France to prevent the Spanish conflict from extending beyond the Spanish borders, most outside aid for the Popular Front government was shut off by the nonintervention policy of the democratic powers; and, in spite of the support of most of the population, as well as the moderate and Left political parties, the republic fought a losing battle against the assist-

# SPAIN

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## SPAIN

Area.....194,945 sq. m.
Population...27,800,000

KEY TO MAP SYMBOLS

- ⊛ National Capital
- • Size of symbols and type indicates relative population.

CITIES AND TOWNS


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# SPAIN AND PORTUGAL

Mediterranean Sea
Atlantic Ocean
Gulf of Lions
FRANCE
PYRENEES
NAVARRE
ARAGON
CATALONIA
ANDORRA
Andorra
Barcelona
Zaragoza
Valencia
Murcia
Cartagena
Alicante
Madrid
Chamartín de la Rosa
Vallecas
Toledo
Mancha
Sierra Nevada
BALEARIC ISLANDS
MENORCA
Ciudadela
Mahón
MALLORCA
Palma
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Inca
Sóller
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Andraitx
Lluchmayor
Felanitx
Santañy
CAPE SALINAS
IBIZA
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Santa Eulalia del Río
FORMENTERA
CABRERA I.
Longitude East of Greenwich
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CANARY ISLANDS (SPAIN)
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Teguise
Arrecife
FUERTEVENTURA
Puerto de Cabras
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La Laguna
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Mar Menor
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Pamplona
Bilbao
Vitoria
Estella
Tafalla
Sangüesa
Jaca
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Prats-de-Mollo
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Elne
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St. Laurent-de-la-Salanque
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Laruns
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Pau
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Tarbes
Lourdes
St. Gaudens
Bagnères-de-Bigorre
Bagnères-de-Luchon
St. Girons
Foix
Tarascon
Ax-les-Thermes
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Quillan
Carcassonne
Mirepoix
Pamiers
St. Martory
Lézignan
Limoux
Alet
Sigean
Castelnaudary
Bézier
Coursan
Pic du Midi d'Ossau 9,472 Ft.
Pic Montcalm 10,105 Ft.
Carlit 9,583 Ft.
Pic de Aneto 11,169 Ft.
Perdido 10,998 Ft.
Moncayo 7,595 Ft.
Peña Roya 6,624 Ft.
Sa. de Guara
Sa. de Gúdar
Sa. de Cuenca
Montes Universales
Sa. del Hoyo 4,606 Ft.
Guadarrama
Alcalá de Henares
Torrejón de Ardoz
Coloma de Farnés
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Calella
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Hospitalet
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Sabadell
Tarrasa
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Igualada
Villafranca del Panadés
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Reus
Tarragona
Villanueva y Geltrú
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Egea de los Caballeros
Sangüesa
Tafalla
Estella
Pamplona
Vitoria
Irún
Baztán
Elizondo
Roncesvalles
Aoiz
Lumbier
Sangüesa
Yesa
Sos
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Sádaba
Gallur
Novillas
Tauste
Zuera
Almudévar
Huesca
Monzón
Barbastro
Benabarre
Tremp
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Viella
Sort
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Seo de Urgel
Andorra
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Not shown on map. Index key denotes approximate location.


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## PORTUGAL

**Area . . . . . 35,413 sq. m.**
**Population . . . . 8,510,240**

### CITIES AND TOWNS


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### PROVINCES

Not shown on map. Index key denotes approximate location.


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## GIBRALTAR

**Area . . . . . 2 sq. m**
**Population . . . . . 23,232**

### CITIES AND TOWNS


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## ANDORRA

**Area . . . . . 191 sq. m.**
**Population . . . . . 6,000**

### CITIES AND TOWNS


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ance that Hitler and Mussolini give to Franco and his associates. By the spring of 1939, the organized Popular Front resistance had practically ceased, and General Franco became the dictator of a totalitarian state.

Following his victory, Franco aligned himself with the dictators who had made his success possible. On Mar. 27, 1939, he joined Germany and Italy in the Anti-Comintern Pact, and the Spanish press soon began attacks on the democracies, especially the United States. The idea of Hispanic unity was stressed in Franco's propaganda in Latin America, and everything possible was done to undermine the Good Neighbor policy of President Franklin D. Roosevelt.

*ARMORED CARS AND TANKS MOVING INTO BILBAO AFTER ITS CAPTURE BY THE SPANISH INSURGENTS UNDER GENERAL FRANCISCO FRANCO IN 1937*

WIDE WORLD

**World War II and After.** During the early years of World War II, Spain openly favored the Axis. Through the co-operation of the Falange, which had numerous branches in Latin America, the Axis was able to carry on an intensive propaganda against the democracies in the Spanish-speaking countries of the Western Hemisphere.

However, Spanish assistance to the Axis powers, particularly Germany, was not confined to propaganda. Actually, in spite of its neutrality, Spain was able to render considerable military and economic assistance during the period from 1939 to 1943. Late in 1941, the Blue Division of Spanish troops was organized on a "voluntary" basis and sent to Russia to assist Germany in fighting the "Red peril." At its height, this force probably numbered from 17,000 to 18,000 men, but by the end of 1943, when it began to be withdrawn because of Allied pressure, it had been reduced to approximately 3,500 men. Its military value apparently had been negligible.

In Spain itself, numerous and active Axis agents received full co-operation from the Spanish police. Although constant protests were made by the United States and Great Britain, these agents were given practically a free hand to carry on their espionage work. In spite of the government's promise on May 2, 1944, to begin the expulsion of known Axis agents, many of them were still in Spain when the war ended. In addition, German and Italian vessels often obtained illegal entry to Spanish ports, although complaints from the United States and England tended to restrict this practice after 1943. In the economic sphere, Spain supplied the Axis nations, especially Germany, with food, hides and skins, woolens, and certain strategic raw materials such as wolfram, iron ore, and mercury. Also, Hitler presented Franco with a bill of 374,000,000 reichsmarks for the services of the German Condor Legion in the civil war, and thus Spain was made to assist in the financing of the war against the Allies.

Despite close contacts with the Axis nations, however, Spain was able to stay out of the war. This was partly because of Franco's unwillingness to go to war, and partly because of Hitler's doubts about Spain's military effectiveness, but pressure from the United States and Great Britain also was instrumental in keeping Spain neutral. Spain's acute need of oil, which Germany could not supply, eventually proved a powerful weapon in the hands of the democracies. By threatening to place an embargo on petroleum shipments to Spain, the Allies were able to force Spain to sell them valuable war materials that otherwise would have gone to the Axis.

During the Potsdam Conference following the collapse of Germany, the Allies made it clear that Spain would be allowed no part in the remaking of Europe, and on Feb. 8, 1946, Spain was excluded from the United Nations. Later, when Franco executed ten Spanish republicans who had also fought in the French underground during World War II, there was a violent outcry in France, and on Feb. 28, 1946, the French government was forced to close the Hispano-French frontier. On March 4, Great Britain, France, and the United States publicly announced that they hoped to see the retirement of Franco and the formation of an interim government pending the establishment of one by the free choice of the Spanish people. Shortly afterwards, Poland, supported by the Soviet Union, openly attacked the Franco regime in the United Nations, and on June 1, a subcommittee of the United Nations brought in a report which held that the dictatorship in Spain constituted a potential threat to peace.

However, it soon was apparent that the opponents of

## RULERS OF SPAIN

| Dates of Reign | | Name of Ruler | Succession | Born | Died |
|---|---|---|---|---|---|
| | | | **THE GOTHIC KINGDOM** | | |
| 414 | 415 | Ataulphus (Atawulf) | Brother-in-law of Alaric I, leader of the Visigoths; invaded Spain and founded the Gothic (Visigothic, or Western Gothic) kingdom; assassinated by Sigeric | ? | 415 |
| 415 | 415 | Sigeric | Usurped throne; assassinated 7 days later | ? | 415 |
| 415 | 419 | Wallia | Elected king | ? | 419 |
| 419 | 451 | Theodoric I | Son of Alaric I; killed at the Battle of Châlons-sur-Marne | ? | 451 |
| 451 | 453 | Thorismond | Eldest son of Theodoric I; murdered by brother, Theodoric II | ? | 453 |
| 453 | 466 | Theodoric II | Son of Theodoric I; murdered by brother, Euric | 426 | 466 |
| 466 | 484 | Euric | Son of Theodoric I | ? | 484 |
| 484 | 507 | Alaric II | Contracted to Theudegotha, daughter of Theodoric, Ostrogothic king of Italy, 495; killed in battle, 507 | ? | 507 |
| 507 | 510 | Giselic | Natural son of Alaric II; fled to Africa | ? | 510 |
| 507 | 510 | Amalaric | Infant son of Alaric II; Thiodes appointed guardian of the child king | c. 502 | 531 |
| 510 | 531 | Amalaric, alone | Son of Alaric II; end of regency | c. 502 | 531 |
| 531 | 548 | Thiodes (Theudas) (Theudis) | Appointed guardian of Giselic and Amalaric; on death of latter, assumed the throne; assassinated | ? | 548 |
| 548 | 549 | Theudisculus | Killed by people | ? | 549 |
| 549 | 554 | Agila | | ? | 554 |
| 554 | 567 | Athanagild | | ? | 567 |
| 567 | 572 | Liuva I | Sons of Athanagild | ? | 572 |
| 572 | 586 | Leovigild | | ? | 586 |
| 586 | 601 | Recared I | Second son of Leovigild | ? | 601 |
| 601 | 603 | Liuva II | Son of Liuva? assassinated by Witteric | ? | 603 |
| 603 | 610 | Witteric | Usurped the throne; killed | ? | 610 |
| 610 | 612 | Gundemar | | ? | 612 |
| 612 | 620 | Sisebut (Sisebert) | | ? | 620 |
| 620 | 621 | Recared II | Son of Sisebut | ? | 621 |
| 621 | 631 | Suintilla (Swintila) | First Gothic monarch of all Spain | ? | 631 |
| 631 | 636 | Sisenand | | ? | 636 |
| 636 | 640 | Chintilla (Chintila) | Recognized as king by Council of Toledo | ? | 640 |
| 640 | 641 | Tulga | Deposed | ? | ? |
| 641 | 653 | Chintasuinthus | | ? | 653 |
| 653 | 672 | Recesuinthus (Receswind) | Son of Chintasuinthus; associated with father on throne | ? | 672 |
| 672 | 680 | Wamba | Forced to take throne; deposed; retired to monastery | ? | 683 |
| 680 | 687 | Ervigius | Recognized by Council of Toledo, 681 | ? | 687 |
| 687 | 701 | Egica (Ergica) | Son-in-law of Ervigius | ? | 701 |
| 710? | 711? | Roderick (Rodrigo) | A descendant of Chintasuinthus; last of the Visigothic kings; killed at the Battle of Río Barbate when the Saracens invaded Spain | ? | c. 711 |
| | | | **CHRISTIAN STATES DURING MOORISH PERIOD** | | |
| 718 | 737 | Pelayo (Pelagius) | A royal Visigoth, chosen by the Asturians as their leader; assumed the title of king, 718; took city of León 721, founding a new kingdom | ? | 737 |
| 737 | 739 | Favila | Son of Pelayo; killed while hunting | ? | 739 |
| 739 | 757 | Alfonso I the Catholic | A descendant of King Recared; elected king 739; succeeded in expelling Moors from León and Galicia | ? | 757 |
| 757 | 768 | Fruela (Froíla) I | Son of Alfonso I, assassinated by Aurelius | 722 | 768 |
| 768 | 774 | Aurelius (Aurelio) | Cousin of Fruela I | ? | 774 |
| 774 | 783 | Silo | Brother-in-law of Aurelius; took Alfonso II, son of Fruela, as his colleague, 775 | ? | 783 |
| 783 | 788 | Mauregatus (Mauregato) | Natural son of Alfonso I; half uncle of Alfonso II | ? | 788 |
| 788 | 791 | Bermudo I the Deacon | Nephew of Alfonso I; resigned throne to Alfonso II and retired to a monastery | ? | 791 |
| 791 | 842 | Alfonso II the Chaste | Son of Fruela; was excluded from the throne by Mauregatus, 783 | ? | 842 |
| 842 | 850 | Ramiro I | Son of Bermudo; king of León; elected by nobles to succeed Alfonso II | c. 791 | 850 |
| 850 | 866 | Ordoño I | Son of Ramiro I | ? | 866 |
| 866 | 910 | Alfonso III the Great | Eldest son of Ordoño I; resigned crown to sons | 848 | 912 |
| 910 | 914 | Garcia (García) | Son of Alfonso III; king of León | ? | 914 |
| 910 | 923 | Ordoño II | Son of Alfonso III, king of Galicia; on death of his brother Garcia, united Galicia with León | ? | 923 |
| 923 | 925 | Fruela II | Son of Alfonso III; on death of Ordoño II, usurped thrones of León and Navarre, 923 | ? | 925 |
| 925 | 930 | Alfonso IV | Eldest son of Ordoño II; abdicated to retire to a monastery | ? | 933 |
| 930 | 950 | Ramiro II | Brother of Alfonso IV; younger son of Ordoño II; abdicated in favor of his son | c. 923 | 950 |
| 950 | 955 | Ordoño III | Son of Ramiro II | ? | 955 |
| 955 | 967 | Sancho I the Fat | Younger son of Ramiro II; poisoned | ? | 967 |
| 967 | 982 | Ramiro III | Son of Sancho I; aunt, Doña Elvira, was regent; Ramiro killed in a revolt of the Galicians | 962 | 982 |
| 982 | 999 | Bermudo II | King of León; grandson of Fruela II | ? | 999 |
| 999 | 1027 | Alfonso V | Son of Bermudo II; Gonsalvo his guardian and regent; killed at Viseu | 994 | 1027 |
| 1027 | 1037 | Bermudo III | Son of Alfonso V; León annexed to Castile, 1037; killed in battle against his sister's husband, Ferdinand I | 1016 | 1037 |
| 1037 | 1065 | Ferdinand I (Fernando) | Son of Sancho III of Navarre, king of Castile; received Castile in division of his father's states and founded the kingdom, 1035 | ? | 1065 |
| 1065 | 1109 | Alfonso VI the Valiant (Alfonso I of Castile) | Son of Ferdinand I; received Asturias and León; united with Castile, 1072-1109 | ? | 1109 |
| 1109 | 1157 | Alfonso VII the Emperor | Grandson of Alfonso VI; king of Galicia; continued the Castilian title | ? | 1157 |
| 1157 | 1158 | Sancho III | Son of Alfonso VII; king of Castile | c. 1130 | 1158 |
| 1158 | 1214 | Alfonso VIII | Son of Sancho III; acceded when an infant | ? | 1214 |
| 1214 | 1217 | Henry I (Enrique) | Son of Alfonso VIII; sister, Berengaria, regent | c. 1207 | 1217 |

**RULERS OF SPAIN (*Continued*)**

| *Dates of Reign* | | *Name of Ruler* | *Succession* | *Born* | *Died* |
|---|---|---|---|---|---|
| 1217 | 1252 | Ferdinand III the Saint | Son of Alfonso IX, king of León; inherited Castile from mother; on death of father, joined León and Castile into one kingdom | 1199 | 1252 |
| 1252 | 1284 | Alfonso X the Learned | Son of Ferdinand III | 1221 | 1284 |
| 1284 | 1295 | Sancho IV el Bravo | Second son of Alfonso X | 1258 | 1295 |
| 1295 | 1312 | Ferdinand IV | Son of Sancho IV; mother, Maria della Molina, was regent | c. 1286 | 1312 |
| 1312 | 1350 | Alfonso XI | Son of Ferdinand IV, king of Castile; died of plague | 1312 | 1350 |
| 1350 | 1369 | Pedro (Peter) the Cruel | Son of Alfonso XI; killed by his brother, Henry of Trastamara | 1334 | 1369 |
| 1369 | 1379 | Henry II (Henry of Trastamara) | Natural son of Alfonso XI | 1333 | 1379 |
| 1379 | 1390 | John I (Juan) | Son of Henry II | 1358 | 1390 |
| 1390 | 1406 | Henry III | Son of John I | 1379 | 1406 |
| 1406 | 1454 | John II | Son of Henry III; uncle, Ferdinand I, of Aragon, resigned regency in 1412 | 1405 | 1454 |
| 1454 | 1474 | Henry IV the Weak | Son of John II | 1425 | 1474 |
| | | | **FOUNDATION OF SPANISH MONARCHY** | | |
| | | | **House of Aragon** | | |
| 1474 | 1504 | Isabella I the Catholic | Daughter of John II, king of Castile; half-sister of Henry IV | 1451 | 1504 |
| 1474 | 1516 | Ferdinand V the Catholic | Son of John II, king of Aragon; married Isabella, 1469; inherited crown of Aragon as Ferdinand II, 1479, thus uniting Spain; regent for Juana from 1506 | 1452 | 1516 |
| | | | **Hapsburg Dynasty** | | |
| 1504 | 1506 | Juana la Loca (the Mad) | Daughter of Ferdinand and Isabella; married Philip, archduke of Austria (Philip I of Spain); inherited crown from Isabella; went insane on death of Philip I; Ferdinand assumed government | 1479 | 1555 |
| 1504 | 1506 | Philip I | Son of Maximilian I; married Juana, 1496 | 1478 | 1506 |
| 1516 | 1556 | Charles I | Son of Philip and Juana (Charles V of the Holy Roman empire); as heir to Netherlands and Spain, amalgamated them when elected to Spanish throne; left Spain to Philip II and retired to a monastery | 1500 | 1558 |
| 1556 | 1598 | Philip II | Son of Charles I | 1527 | 1598 |
| 1598 | 1621 | Philip III | Son of Philip II | 1578 | 1621 |
| 1621 | 1665 | Philip IV | Son of Philip III | 1605 | 1665 |
| 1665 | 1700 | Charles II | Epileptic son of Philip IV; mother, Mariana de Austria, was regent; left realm to Philip, grandson of Louis XIV | 1661 | 1700 |
| | | | **BOURBON DYNASTY** | | |
| 1700 | 1746 | Philip V, duke of Anjou | Second son of Dauphin Louis, son of Louis XIV of France, opposed by Archduke Charles, son of Emperor Leopold I; abdicated January 1724 in favor of son, Louis, who died in August; resumed rule | 1683 | 1746 |
| 1746 | 1759 | Ferdinand VI | Second son of Philip V | 1713 | 1759 |
| 1759 | 1788 | Charles III | Third son of Philip V | 1716 | 1788 |
| 1788 | 1808 | Charles IV | Son of Charles III; abdicated in favor of son | 1748 | 1819 |
| 1808 | 1808 | Ferdinand VII | Son of Charles IV; abdicated under pressure from Napoleon | 1784 | 1833 |
| | | | **FRENCH INTRUSION** | | |
| 1808 | 1813 | Joseph Bonaparte | Elder brother of Napoleon I; ousted on his defeat | 1768 | 1844 |
| | | | **BOURBON DYNASTY RESTORED** | | |
| 1814 | 1833 | Ferdinand VII, restored | Son of Charles IV | 1784 | 1833 |
| 1833 | 1868 | Isabella II | Daughter of Ferdinand VII; mother, Maria Christina, regent until 1840; General Espartero regent then until 1843; Isabella ousted by revolution | 1830 | 1904 |
| | | | **SEARCH FOR A KING** | | |
| 1869 | 1871 | Marshal Serrano y Domínguez, Francisco, duke of Torre | Regent | 1810 | 1885 |
| 1870 | 1873 | Amadeus (Amedeo) of Savoy | Elected by moderates; abdicated, 1873; son of Victor Emmanuel II of Italy | 1845 | 1890 |
| | | | **FIRST REPUBLIC** | | |
| 1873 (4 mos.) | 1873 | Estanislao Figueras y Moragas | Chief of the executive power | 1818 | 1882 |
| 1873 (3 mos.) | 1873 | Francisco Pí y Margall | Chief of the executive power | ? | ? |
| 1873 (3 mos.) | 1873 | Nicolás Salmerón | Chief of the executive power | 1838 | 1908 |
| 1873 | 1874 | Emilio Castelar y Ripoll | Prime minister | 1832 | 1899 |
| | | | **BOURBON RESTORATION** | | |
| 1874 | 1885 | Alfonso XII | Son of Isabella II; died of tuberculosis | 1857 | 1885 |
| 1886 | 1931 | Alfonso XIII | Posthumous son of Alfonso XII; mother regent until 1902; exiled; had appointed Primo de Rivera dictator, 1923-1925 | 1886 | 1941 |
| | | | **SECOND REPUBLIC** | | |
| 1931 | 1936 | Niceto Alcalá Zamora y Torres | President | 1877 | 1949 |
| 1936 | 1939 | Manuel Azaña | President; resigned 1939 | 1880 | 1940 |
| | | | **FASCIST DICTATORSHIP** | | |
| 1939 | | Francisco Franco-Bahamonde | General of the Spanish army; became dictator | 1892 | |

Franco could not agree on what should be done. The subcommittee's report was not accepted, and motions by the Soviet Union and Poland to submit the question to the General Assembly, and to sever diplomatic relations with Spain, were defeated. With the rapid deterioration of the friendship between the Soviet Union and the Western powers, there was less inclination to interfere with a regime in Spain that openly proclaimed itself the bitter foe of communism.

In 1947, by a law passed on March 31, Franco became chief of state for life. The question of a monarchist restoration was evaded by the appointment of a regency council,

pledged to recognize a king of Franco's choosing in case of the death or incapacity of the caudillo.

Improvement in international relations was indicated by the reopening of the Hispano-French frontier in February 1948. To bolster Spain's shaking economy, Franco made repeated overtures toward the Western nations, particularly the United States, for aid and for participation in plans for the unity and defense of the West. The United States House of Representatives' approval of Marshall Plan aid to Spain was rejected by President Truman in April 1948. Throughout 1949 and up to Sept. 6, 1950, when the president refused to grant the loan to Spain of $62,500,000 authorized by Congress in the omnibus appropriation bill, the problems confronting the Franco regime remained unsolved—economic aid, membership in the United Nations, and participation in European defense as a signatory of the Atlantic Pact.

As a result of the growing hostility between the free world and the Soviet system, however, United States policy toward Spain was revised, and diplomatic relations were reestablished Dec. 27, 1950, when President Truman appointed Stanton Griffis American ambassador to Madrid. England and France followed suit. Because of Spain's strategic location and its importance to the West in the cold war, Adm. Forrest Sherman visited Franco in July 1951 for important conversations; it was agreed that Spain would not come into NATO but would sign a separate agreement with the United States. In spite of protests from England and France, President Truman in October 1951 signed the foreign aid bill allotting $100,000,000 to Spain for military and economic assistance. In April 1952 Franco further strengthened his diplomatic position when at a conference with Dr. Antonio de Oliveira Salazar, premier of Portugal, it was announced that Portugal considered the Iberian Peninsula a strategic unity. Since Portugal was a member of NATO, this announcement was taken as a strong hint that Spain would have to be included in any agreement between Portugal and the West for the defense of Europe. At the same time, Spanish diplomats were suggesting to the Moslem countries of the Middle East that Spain, because of its Mohammedan background, was particularly fitted to mediate between East and West. In August 1952 both England and France persuaded West Germany to exchange ambassadors with Spain. *See also* SPANISH COLONIAL EMPIRE, THE. J. F. R.

**SPAIN, TREATY WITH** (1819), also known as the Adams-Onís Treaty, defining the western boundary of the United States and providing for the cession of the Floridas by Spain. It was signed at Washington on Feb. 22, 1819, by Secretary of State John Quincy Adams and the Spanish minister, Luis de Onís and was ratified by Spain on Feb. 21, 1821.

Under the terms of the treaty, Spain gave up all claims to both East and West Florida. The western boundary of the Louisiana Purchase was clearly defined for the first time: beginning at the mouth of the Sabine River, the line zigzagged in a northwestward direction to the forty-second parallel, the present northern limit of California, then proceeded directly west to the Pacific Ocean. In effect, Spain transferred to the United States all its claims to the Oregon country. In return, the United States gave up whatever title to Texas it had acquired under the vague terms of the Louisiana Purchase. It also assumed, to a limit of $5,000,000, the claims of its citizens against Spain. Certain tariff privileges were accorded Spanish goods in Florida ports. R. W.

**SPALATO.** *See* SPLIT (*Ital.* SPALATO).
**SPANDREL.** *See* ARCHITECTURAL TERMS.
**SPANIEL.** *See* DOG.

**SPANISH,** a language spoken by most Spaniards and even by Catalans, Basques, and Galicians, who are in general bilingual; it is moreover the official and cultural language of all the Central and South American republics except Brazil. It is spoken in the Spanish colonies, the Philippines, and some southern sections of the United States, and the Ladinos of the Eastern Mediterranean also speak a sort of archaic Spanish. Spanish is spoken on four continents by probably more than 100,000,000 persons.

The history of the Spanish literary language is very similar to that of French: it is the history of the growth and expansion of a local dialect. In the case of Spanish, this dialect was that of Old Castile, in the north, which prevailed essentially because of the political conquests of the Castilian kings, who progressively unified under their command the whole Iberian peninsula with the exception of Portugal. Before that time the Latin inhabitants of the central and southern parts of Spain and Portugal, which were under the domination of Islam, had preserved their Latin character to a greater degree than had those of the less united northern portions of Spain, and they had developed a language called Mozarabe, which is little known, but which was certainly much more archaic than Spanish or Portuguese. The Mozarabic dialects were entirely uprooted and replaced by Castilian and Galician at the time of the Christian reconquest of Spain and Portugal from the Moors, and this sudden and radical linguistic change explains the relatively uniform subsequent character of the language in the southern parts of the peninsula. This spread of Castilian innovations, such as initial *h-* for *f-*, to the south split the old peninsular dialects once extending from Catalonia and Aragón on one side to León and Portugal on the other, and Catalan and Portuguese thus preserve certain archaic features which Castilian has eliminated from the central zone.

The oldest important documents in Spanish are the *Glosas Emilianenses,* composed in the Monastery of San Millán de la Cogolla, in Rioja, and the *Glosas Silenses,* composed in the Monastery of Silos, not far from Burgos. They are notes written on the side of a few homilies and a penitential, and in them the monks translated into their dialect, which was of a Navarro-Aragonese type, the Latin sentences and words they did not readily understand. These documents belong to the tenth century, but a Romance language was certainly spoken long before that in Spain; the first literary text is the famous *Cantar de mío Cid,* composed around 1140, and this was certainly preceded by many other epic poems written in Romance.

The main characteristics of Castilian which differentiate it from other Romance languages are: (1) the diphthongization in almost every position of Latin *ĕ* and *ŏ,* as in *tiempo* and *cuerno,* where Portuguese, Catalan and Provençal do not diphthongize and Italian and French do so only in unchecked syllables, as *viene, vient* and *muore, meurt* (but *tempo, temps; corno, cor*); (2) the change of *-ly-* through *-ž- to -χ-,* as in the shift from *palea* through **palya* to *paja,* where Italian and French have *ʎ,* and then often *y;* (3) the shift of the Latin group *-ct-,* which, after becoming *-it-* as in all Western Romance languages, proceeds further to *č* (written *ch*) as in the shift from *octo* to *ocho* which does not take place in Portuguese, Aragonese, Catalan, Provençal, or French, *č* being therefore a typical Castilian innovation; (4) the passage of *x* to *š* (as preserved in Portuguese) and then *χ,* as

in the shift from *axem* to *eje* or *dixi* to *dije;* (5) the palatalization of initial voiceless consonants plus *-l-* (*pl-, cl-, fl-*) to *ll-* (*ļ*), as in the shifts *plenum* to *lleno, clavem* to *llave* and *flamman* to *llama,* where Portuguese and Leonese have *č-,* French preserves *cl-, pl-, fl-,* and Italian has *ky-, py-, fy-;* (6) the change of the Latin *-mb-,* which is preserved in Mozarabic, Leonese, Portuguese, Galician, and most other Romance languages, except Aragonese and Catalan, to *m* (through *mm*), as in the shifts *palumbam* to *paloma* and *lumbum* to *lomo* (Cat. *llom*), where Mozarabic retains *polombina,* Portuguese *pomba,* and Leonese *palomba;* and (7) the change of *-m(i)n-* to *-mbr-* as in the shift of **hominem* to *hombre.* When *-l-* occurred before a consonant it once became *-u-,* as in the change from *alt(e)rum* to *otro,* but a learned influence then restored the *-l-* in almost every case, as in *alto.*

The Spanish vocabulary contains derivatives of a great many ancient Latin words which have disappeared or changed their meaning in most or even all other Romance countries, retaining, for example, Spanish forms of the Latin *comesse* (*comedo*), *perna, mensa, angustus, metus, formosus, malus, follis, fabulari, materia,* and many others. The Arabic influence was also very strong in Spain, much more than in any other Romance country, and this is clearly reflected in the many Arabic words which remain in Spanish, especially in the fields of administration (*alcalde, alguacil, aldea*), trade (*almacén, arancel, zoco, almoneda*), and construction (*albañil, azotea, azulejo, alcantarilla*). Italian has also exercised a very strong influence on the Spanish lexicon.

Spanish has not changed very much from the times of the Cid, certainly much less so than French and English, though more than Italian. The most significant changes are the passage of *f-* to *h-* (now mute) and the unvoicing of *-z-, -ž-,* and *-ž-,* which therefore fused with *-s-, -θ-,* and *-š-* (once written *x,* now *j,* and pronounced *χ*). Thus Ladino preserves *mužer* and *bašo,* whereas Spanish has *mujer* and *bajo.* Final *-e* was dropped in bi-syllabic nouns, the earlier *pece* now being *pez.* The distinction between *v* and *b* was also eliminated, although it is preserved in Ladino.

American Spanish is not very different from the European variety, but it frequently confuses *c, z* (*θ,* Eng. *th* of *thick*), and *s* in a process known as *seseo,* and aspirates *s* before a voiceless consonant, *hasta* being pronounced *aḥta* and even *atta;* both of these are Andalusian characteristics. In Argentina the lower classes still use the ancient *vos* in respectful address instead of *Usted.* G. B.

**SPANISH AFRICA,** a term applied collectively to all of Spain's possessions in north, west, and central Africa. In fact, Spanish Africa has included all of Spain's overseas territories since the loss of her colonies in the West Indies and the Far East after the Spanish-American War of 1898. The Canary Islands, which form two provinces of Spain proper, are not included in this term, although geographically the islands are united with Africa rather than Europe. Spanish Africa is divided into three districts: (1) Spanish Morocco, including five presidios of Spanish sovereignty, the Spanish Protectorate composed of a northern and southern zone, and the Ifni territory; (2) Spanish Sahara, composed of Saguiet el Hamra and Rio de Oro (the southern zone of Spanish Morocco is sometimes thought of as a part of Spanish Sahara); and (3) Spanish Guinea, composed of Fernando Po, Annobón, Corisco, the Elobeys, and Continental Guinea.

**Administration.** Political and administrative conditions vary considerably in the several parts of Spanish Africa. The five "places of sovereignty" on the north coast of Morocco, also known as the presidios—the two cities of Ceuta and Melilla and the islands of Alhucemas, Chafarinas, and Peñón de Vélez de la Gomera—though integral parts of Spain, are in certain matters governed by the High Commissioner and the Comandancia Militar of Spanish Morocco. The northern and southern zones in Morocco constitute a protectorate, in which the Sultan of Morocco is still nominally sovereign, but they are administered by the High Commissioner, who also administers the Ifni enclave. Spanish Sahara consists of three parts, in only two of which, Saguiet el Hamra and Rio de Oro, is Spain officially sovereign. The third and northernmost part, where Cabo Yubi, the administrative center of Spanish Sahara, is located, is the southern zone of the protectorate of Morocco, where the Sultan of Morocco is nominally supreme. Rio de Oro is a colony, and Saguiet el Hamra, described officially as a "zone of free occupation," must also be regarded as colonial in status. Both are administered by the High Commissioner. Spanish Guinea, including Fernando Po, Annobón, Corisco, and the Elobeys, is a colony and is administered by a governor. *See also* Annobón; Canary Islands; Continental Guinea; Corisco; Elobey; Fernando Po; Guinea, Spanish; Ifni; Morocco; Spanish Sahara. R. G. W.

**SPANISH-AMERICAN WAR** (1898), a conflict between the United States and Spain which had its origin in the Cuban insurrection of February 1895. The ruthless methods used by the insurgents and the Spanish government to achieve victory led to widespread devastation and hardship for the Cubans and losses to American business.

**Background.** Several factors operated to impel the United States toward intervention: (1) *Juntas* of Cuban patriot refugees in the United States kept the flames of revolt alive in Cuba by furnishing arms and supplies to the insurgents and served as centers of propaganda in the United States to enlist American sympathies; (2) William Randolph Hearst and Joseph Pulitzer vied with each other in promoting their newspaper sales by one-sided reporting of the alleged cruelties of the Spanish in suppressing rebellion, thus inflaming American opinion; and (3) public men, including politicians and clergymen, preached a virulent manifest destiny theme that emphasized the mission of the United States in assuming the burden of civilizing backward peoples. President Grover Cleveland and, at first, President William McKinley, supported by the business interests of the country and by some politicians, resisted all pressure for intervention and sought to achieve peace by diplomacy. Following the destruction of the U.S.S. *Maine* in Havana harbor Feb. 15, 1898, McKinley was unable or unwilling to resist the public clamor for war, despite his success through diplomacy in finding a solution to the Cuban problem. On Apr. 11, 1898, McKinley asked Congress for authority to use the military and naval forces of the United States to end hostilities in Cuba. Congress, by a joint resolution, approved on Apr. 20, demanded the recognition of Cuban independence and the withdrawal of Spain from the island, directed the President to use the entire land and naval forces of the United States to accomplish these ends, and disclaimed any intention to exercise sovereignty over Cuba, except for pacification. Spain, upon receiving news of this resolution, broke off diplomatic relations, whereupon the President asked Congress for a declaration of war. On Apr. 25, 1898, Congress by joint resolution declared that a state of war existed between the United States and Spain, beginning April 21.

**Military and Naval Campaigns.** The President on April 22 proclaimed a blockade of certain Cuban ports and on the following day he issued a proclamation calling for

125,000 volunteers. On April 24 Commodore George Dewey, commanding the Asiatic Squadron, received orders to proceed from Hong Kong to the Philippines to engage the Spanish fleet assembled there. Dewey's destruction of the Spanish fleet in the Battle of Manila Bay on May 1, 1898, proved to be the most notable victory of the war and led eventually to the occupation of Manila and the cession of the Philippine Islands by Spain to the United States.

*THE EXPLOSION OF THE UNITED STATES BATTLESHIP MAINE IN HAVANA HARBOR ON FEBRUARY 15, 1898*

FROM THE DRAWING BY W. LOUIS SONNTAG, JR.

COURTESY OF THE NEW YORK PUBLIC LIBRARY

Admiral Pascual Cervera, with the Spanish Atlantic Fleet, evaded the American blockade and entered the harbor of Santiago de Cuba, May 19, 1898. An American fleet commanded by Admiral William T. Sampson blockaded Cervera, while 17,000 regulars and volunteers assembled at Tampa, Fla., for transport to Cuba to co-operate in the capture or the destruction of the Spanish fleet. An expeditionary force commanded by General William R. Shafter landed east of Santiago late in June and on July 1, 1898, stormed the heights of San Juan and El Caney, overlooking Santiago Bay, thus making Cervera's position untenable. The troops included the Rough Riders, recruited by Lt. Col. Theodore Roosevelt and commanded by Col. Leonard Wood. Fleeing the harbor on July 3, the Spanish fleet was destroyed by an American squadron in a short engagement, thereby paving the way for the surrender of Santiago to Shafter on July 14. General Nelson A. Miles began the subjection of Puerto Rico July 25, 1898, while a third army under General Wesley Merritt landed outside of Manila and proceeded, with the aid of Dewey's ships and of the insurgent forces under Emilio Aguinaldo, to invest the city, Aug. 13, 1898.

**Treaty of Paris.** After the capitulation of Santiago, Spain began peace overtures through the French minister at Washington. The two governments terminated hostilities August 12 by signing a peace protocol under which Spain relinquished Cuba, ceded Puerto Rico and one of the Marianas to the United States, and agreed to pay for American occupation of Manila until the peace commission disposed of the Philippines. American and Spanish commissioners arranged terms of peace in the Treaty of Paris, signed Dec. 10, 1898. The United States Senate, following a strong but ineffective attack by the anti-imperialists against the document, ratified the treaty Feb. 6, 1899. The war cost the United States about $250,000,000 and 5,000 lives. There were less than 400 battle casualties; the remainder represented the disease toll. Inefficiency, incompetence, and bungling marked certain phases of the prosecution of the war. Secretary of State John Hay characterized it as "a splendid little war." The war marked the end of Spain's New World empire and the rise of the United States as a major power. G. H. K.

**SPANISH BAYONET.** *See* YUCCA.

**SPANISH BROOM,** a long-blooming shrub, *Spartium junceum,* of the pea family, closely related to, and similar to, the common broom, *Cytisus.* It grows to a height of 10 ft. The flexible green twigs, generally leafless, bear a succession of brilliant yellow, fragrant, pealike flowers. Native to the Mediterranean region, the plant can be grown in the central United States. J. C. Wis.

**SPANISH COLONIAL EMPIRE, THE,** beginning with the discoveries of Columbus and ending with the Spanish-American War of 1898, one of the first and most successful of the early colonial enterprises. During the sixteenth century, when neither England nor France was able to establish a single permanent colony, Spain founded an empire that included Mexico, Central America, South America except Brazil, and numerous islands in both the eastern and western hemispheres. The seventeenth and eighteenth centuries comprised a period of rivalry among the Dutch, British, and French colonial empires. The integrity of the Spanish empire was defended successfully, however, until the end of the Napoleonic Era, when it was destroyed by colonial revolutions.

Columbus' initial voyage of discovery in 1492 was followed rapidly by the establishment of colonies, and for the next fifty years discovery and colonization proceeded concurrently. Within a generation after Columbus, Spaniards had occupied the West Indies, and were exploring the mainland of North and South America from Florida to the Río de la

Plata. In 1513 Panama was crossed and the Pacific Ocean discovered; Cortés reached Mexico in 1519, and the following year Magellan discovered the strait to which he gave his name. With the conquests of Cortés, the base for exploratory activities moved from the West Indies to Mexico, and expeditions into the northern areas followed quickly. De Soto traveled from Florida up to the Carolinas and eventually to the Mississippi in 1539-1540. During 1540-1542 Coronado made the spectacular journey that took him as far north as Kansas, and in 1542-1543 Cabrillo and Ferrelo sailed up the California coast to a point just beyond the present Oregon-California line.

In the exploration of South America, Panama was used as a base; in the 1520's, a few short expeditions were made to the outskirts of the Inca Empire. Between 1531 and 1533 this fabulously rich area was added to Spanish possessions by Pizarro, while the areas of modern Colombia and Bolivia were conquered a few years later. Chile was occupied by Valdivia during the 1540's and 1550's in spite of great opposition from the Indians. The Río de la Plata area had been touched as early as 1516, but little was done to incorporate it into the empire until the founding of Asunción in 1538; henceforth this city served as a base for explorations toward the coast. After an earlier unsuccesful attempt, Buenos Aires was refounded permanently in 1580 by Juan de Garay, and eventually became the most important metropolis of the southern regions. Outside the Americas, Spain occupied the Philippines in 1564-1565; by the end of the century, she had acquired a few small holdings in the Far East and along the African coast.

**Sixteenth Century.** The sixteenth century was also important for the development of colonial institutions and policies. Early colonial problems were assigned by Ferdinand and Isabella to Bishop Juan Rodríguez de Fonseca, but in 1503 a house of trade known as the *Casa de contratación* was established to assist him in the regulation of American emigration and trade. In 1524 the Council of the Indies began to function directly under the Crown as a supervisory and policy-making body for all colonial affairs. In the colonies themselves, the Crown soon recovered the initial concessions made to Columbus, and thereafter jealously guarded its supremacy by making limited grants of land and authority to the various conquistadors. To check the violent rivalries between them, it was soon necessary to establish some supreme colonial authority able to control and to compel respect; consequently, in 1529 the Viceroyalty of New Spain was created, including Mexico, Central America, and the Caribbean. Shortly afterward the Viceroyalty of Peru was instituted including all territory south of the northern viceroyalty. Until the accession of the Bourbon dynasty in the early 1700's, all the Spanish colonies in the New World were grouped under these two major divisions. Under each viceroy, the colonies were governed by various governors and captains-general. Judicial problems, plus additional administrative duties were handled by special courts known as *audiencias,* which numbered fourteen by the end of the eighteenth century.

**Colonial Society.** Spanish colonial society naturally reproduced the most important institutions and social strata of the mother country. Purity of religion was an important factor in colonial life, and the Catholic Church was as powerful and privileged as it was in Spain. Vigor was not wanting in the intellectual activities of the colonies; a printing press was established early in Mexico City, and in time academies, colleges, and universities appeared in the principal cities. The highest rank in colonial society was reserved for officials of Spanish birth; next came Spaniards of wealth born in the colonies; lowest of all were the poor whites, half-breeds, and native Indians. Relations with the Indians presented a difficult problem for the Spanish government. Beginning with Queen Isabella, Spanish sovereigns had insisted that the Indians were not to be treated as a slave class. However, in spite of the official doctrine, colonial practice was to make them practically that. Many Indians were forced to labor in mines, or on estates in various forms of serfdom. The two commonest systems of enforced labor were known as the *encomienda,* and the *repartimiento.* Besides the exploitation of the Indians, Spanish interest centered in mining, especially in gold and silver which was richly distributed throughout Hispanic America; the pastoral industries, agriculture, and commerce also were developed energetically. In accordance with the economic ideas of the time, trade with the colonies was restricted entirely to Spain by law. In spite of this, however, Great Britain, France, and the Netherlands were able to develop a rich smuggling trade with the Spanish colonies during the seventeenth century.

**Eighteenth Century.** The last century of Hapsburg rule in Spain was a period of decline, but the arrival of the Bourbons in 1700 introduced a century of remarkable recovery. In the colonies, this produced successful reforms of colonial institutions, new explorations chiefly in what were later New Mexico, Arizona, and California; and the generally successful defense of the empire against attacks by Great Britain. Although Spain lost Florida to Great Britain in 1763, France ceded the vast Louisiana Territory to her in compensation for the loss and Florida was recovered in 1783. Administrative improvements during the Bourbon period included the establishment of the Viceroyalty of New Granada, 1717, and the Viceroyalty of Río de la Plata, 1776. In addition, to strengthen the northern frontier of the Viceroyalty of New Spain, important cities such as San Diego, Los Angeles, Monterey, and San Francisco were founded. In 1800, by the Treaty of San Ildefonso, Spain returned the Louisiana Territory to France.

**Nineteenth Century.** The American and French revolutions greatly stimulated tendencies toward independence already latent in the colonies, but nothing overt occurred until the Napoleonic period. When Napoleon occupied Spain in 1808 and forced the Spaniards to accept his brother Joseph as king, revolts against the new regime occurred throughout the Spanish colonial world. In the course of a few years, most of these revolts against French control were transformed into movements for colonial independence, and when Great Britain in 1819 indicated her opposition to any re-establishment of Spanish control; it was clear that the empire was gone forever. All that remained were Cuba and the Philippines, and small holdings in the Caribbean, Africa, and the Far East. During the nineteenth century, a powerful independence movement developed in Cuba as a result of the severity and inefficiency of Spanish rule there. Spanish efforts to put down this movement finally involved it in war with the United States in 1898 which resulted in the American acquisition of the Philippines, Guam, and Puerto Rico, and the establishment of Cuba as an independent nation. This marked the end of the once great Spanish colonial empire.

**Spanish Africa.** Although not on the same scale as the vast holdings in the Western Hemisphere, the lands Spain had gradually acquired in Africa were its only overseas possessions in the twentieth century. Spain had invaded Morocco in the early sixteenth century and held several presidios along the coast. In the late nineteenth century Spain invaded northern Morocco in order to expand its holdings inland; at the

same time it intervened in the Sahara. Ifni was ceded to Spain by Morocco in 1860, though occupation was nominal until 1934. Its boundaries, as well as those of Spanish Sahara and Spanish Morocco, were set by treaties with France in 1904 and 1912, though Ifni's area was reduced in 1935. Of the constituent parts of Spanish Guinea, Fernando Po was ceded to Spain by Portugal in 1778; the islands of Corisco and Elobey were annexed in 1846; and continental Guinea, for which Spain claimed an area extending inland to the Ubangi River, had its bounds settled at the Convention of Paris in 1900. *See also* FERNANDO PO; IFNI; MOROCCO; SPANISH SAHARA. J. F. R.

**SPANISH FLY,** the name given to the blister beetle, *Lytta vesicatoria,* of the family Meloidae. This species occurs in abundance in parts of Europe, feeding chiefly on ash and privet. When dried and powdered, the Spanish fly has long been used as a blistering agent, and is the chief source of cantharidin, which occurs in the elytra or wing covers. Because blistering, the deliberate use of an irritant to counteract local infection, is little practiced today, the importance of the cantharidin industry has declined greatly. Cantharidin was also used as an aphrodisiac, or love potion. Since its internal use is extremely dangerous, the sale of cantharidin is prohibited by law in many countries.

C. H. Cu.

**SPANISH FORK,** a city in the north central section of Utah, in Utah Co., situated about 60 mi. south of Salt Lake City, 4,570 ft. above sea level, with the Wasatch Mountain range and Spanish Fork peak to the east, Utah Lake to the west, and Mt. Nebo (11,871 ft.) to the south. The city was incorporated in 1855. Spanish Fork is governed by a mayor and council. A local feature is a monument commemorating what is said to have been the first Icelandic settlement in the United States. Transportation is furnished by the Union Pacific and the Denver & Rio Grande Western railroads. Stock and poultry raising are important interests of the region. The farm crops include hay, grains, sugar beets, and vegetables. Local industrial plants include a sugar-beet factory, foundry, packing plant, poultry-processing plant, and plastic factory. Pop. 1950, 5,230.

**SPANISH GUINEA.** *See* GUINEA, SPANISH.

**SPANISH LITERATURE.** Literature in the Spanish language has been for more than eight hundred years the vehicle of expression for the culture of one of the most original peoples of Europe. Although the other languages spoken in the Iberian Peninsula—Portuguese, its medieval antecedent Galician, and Catalan—possess valuable literatures, they nevertheless lack the richness and the sustained continuity of the literature of Castile, the central region, and it was Castilian that became the language preferred for literary purposes by all Spaniards after the sixteenth century.

**Characteristic Aspects.** One of the more peculiar traits of this literature is the relatively limited evolution of its language since the twelfth century compared with the profound transformations experienced by the French or the English languages of the Middle Ages. Thus, a Spaniard familiar with the literary language of today understands the general meaning of a twelfth-century text of the *Cantar de mio Cid,* or the thirteenth-century *Siete Partidas* ("The Seven Divisions") of Alfonso, and between the fourteenth and seventeenth centuries the language, the religion, the thoughts, and the life in general of Spain did not change as markedly as in England, France, or Germany.

In the sixteenth century a number of poetic forms and literary genres of Italian origin penetrated into Spain and may be seen in the theatre of Juan del Encina, the poetry of Garcilaso de la Vega, the pastoral novel of Jorge de Montemayor, and epic poems of the Renaissance type, like *La Araucana* of Ercilla, but medieval epic themes nevertheless continued to live through the *romancero* and the national drama. In other European countries, epic themes continued among the rustic people only. This mixture of new with traditional art and of learned with ingenuous themes gives a spontaneous air to Spanish literature and at times deprives it of reserve and moderation, but it is this very blending which, although it either disturbs or charms foreigners, accounts for the great originality of the literature and the fact that it is always interested in embracing and in expressing the totality of human life. In the theatre of Lope de Vega, for example, there are both aristocratic and plebian personages, tragic and comic elements, the Italian hendecasyllable beside the traditional octosyllable, and complicated metaphors joined to the lowest slang.

In the same way, both religious and worldly themes are interwoven, for in the soul of the Spaniard God and the world are very close. Thus, during the seventeenth century there was a superabundance of religious works, but on the other hand, there were very few scientific writings of a theoretical character. The Spaniard preferred to busy himself with the moral problems of human existence and conduct, and in general, works of literature, history, politics, or religious morality occupied in Spanish life a place which in other countries was shared with science and technology. That which the Spanish are, feel, desire, and think is found in their literary creations rather than in their treatises on science and philosophy.

**The Medieval Period.** We do not properly consider as Spanish the literature written in Latin during the Roman epoch of Seneca, Lucan, Martial, and Prudentius; under the Visigoths during the sixth and seventh centuries when the works of Saint Leander and Saint Isidore of Seville were written; or afterwards. The language is in this case an essential element. As long as the Latin of Rome was a live language which was understood by the inhabitants of the Iberian Peninsula, or until the sixth century of the Christian Era, the Iberian people felt themselves a part of the Roman Empire; when written Latin ceased to be spoken and understood, literature in Latin became only a learned exercise, which had no effect upon the majority of the people. Spanish literature began when the language spoken in Castile was converted, in the eleventh century, to a means of expression for the collective feelings of a people with the consciousness of being an independent unit and not just a part of Rome or of European Christianity.

The *cantares de gesta,* or epic poems, are the oldest works of this sort and already existed in the eleventh century, although the original texts have been lost. Their themes were the struggles of Castile to obtain its independence from the kingdom of León and to demonstrate its individuality in relation to the other Christian regions that opposed the Moors. Of this magnificent poetry we possess the *Poema del Cid,* one fragment of *Roncesvalles,* fragments of other epics preserved in some old ballads of the *romancero,* and the prose versions in the chronicles of the thirteenth century, which used the *cantares de gesta* as historic sources.

This epic poetry of Castile differs from that of the remainder of Europe in its historical fidelity and its geographic precision. The anonymous authors of these epics found it necessary to sing of persons and places known to their public,

for the Spaniard did not care for fantastic narratives when he could have poetry based on the contents of his own experience—his heroes, his wars, his cities, and his fields—in short, something that was within reach of his own life. This method of conceiving and presenting reality in relationship with the experience of the writer and of his public is what is customarily called "Spanish realism." The Cid of the *Poema* is thus a hero gifted with all perfections, but at the same time he is also the modest proprietor of a certain mill, the income from which helps him to live. These epic *cantares* on national themes were cultivated in Castile from the eleventh century until the beginning of the fifteenth century, but after the fourteenth century they become more plebian and rough. The *romancero* was, after the fourteenth century, the genre by which the poetic fancy of the people was expressed.

During the thirteenth and fourteenth centuries another form of verse was also cultivated in Spain. This was the so-called *mester de clerecía,* a learned poetry which treated religious themes as in the lives of saints; the history of antiquity, as in the life of Alexander the Great; or moral subjects, of which the *Libro de buen amor* of the Archpriest of Hita is an example. Unlike Spanish epic poetry, which had unequal lines, the *mester de clerecía* used stanzas of four monorhymed lines of fourteen syllables each and revealed the technique which clerical poets of the thirteenth century had derived from Latin and from the literature of France. Their art, nevertheless, was essentially narrative, and did not express personal feeling before the time of the Archpriest of Hita in the fourteenth century.

Before the end of the fourteenth century Castile did not possess a truly lyric poetry, and this is surprising in view of the fact that such poetry is found contemporaneously in the west in Galicia, in the east in Catalonia, in the north in Provence, and in the south in Arab Spain. But Castile found expression in epic poetry, and this none of the above literatures possessed. This Castilian peculiarity may be explained as a defensive reaction against Moslem Spain, whose poetry reflects all kinds of pleasures and vices, for the grave Castile of those centuries did not cultivate a poetry that would have slackened the heroic tensions of its soul, or that would have delighted itself in the expression of the emotions rather than in the account of brave deeds. Morals, history, and law were, on the other hand, preferred themes, as witness the multitude of works composed or translated in the court of King Alfonso the Wise.

The position of Spain suffered great changes at the beginning of the fifteenth century. Only the Moorish kingdom of Granada now remained to be reconquered, the Christian kingdoms of Spain were on the way to becoming united, and the action of Italian Humanism began to be noted. King Juan II (1405-54) and his nobles now lived in hitherto unknown luxury, and literature also took new directions. Lyric poetry now treated of individual love affairs, as it had previously done in the literature of Provence and Galicia, and of episodes in contemporary life, as in the *Laberinto de Fortuna* of Juan de Mena. A Latinate style was now developed, themes from antiquity came into use, and courtly poetry attained its greatest perfection in the *Coplas* of Jorge Manrique on the death of his father. At the same time, an interest in personal life and in the popular spoken language was reflected in the *Corbacho* of Alfonso Martínez de Toledo, where for the first time popular speech was used as a means of literary expression. A further democratizing influence may be seen in the chronicles of the time, which narrate not only the lives of kings but also those of illustrious contemporary personages, for example, Don Álvaro de Luna, a favorite for many years of King Juan II but later executed by his order.

These works and those of many other authors reveal the growing vitality of Castile during the fifteenth century, and with the publication of *La Celestina* of Fernando de Rojas (1499), the influence of a book in Castilian passed for the first time beyond the borders of Spain. Translated into various languages, *La Celestina* had an enormous vogue in Europe, and from that moment Spanish literature took on international proportions. The romances of chivalry represented by *Amadís, de Gaula;* the pastoral novel, represented by the *Diana* of Jorge de Montemayor; and the picaresque novel, represented by the anonymous *Lazarillo de Tormes* and by Mateo Aleman's *Guzman de Alfarache,* charmed Europeans and left perceptible traces in their literature; they were taken as exemplary expressions of heroism, of amorous illusion, and of the critical audacity of that demolisher of social values, the picaro.

**The Golden Age.** The most individual, and at the same time the most universal, values of Spanish literature attained their height of expression in the epoch between the opening of the sixteenth century and the middle of the seventeenth. This period began with the publication of *La Celestina* and ended with the work of Baltasar Gracián, that strange moralist much admired by La Rochefoucauld and Schopenhauer. Spain then reached its highest level of literary attainment and, through Cervantes and Lope de Vega, made of the novel and the drama literary types that deeply influenced subsequent developments outside of Spain. Three elements account for this extraordinary success of literary vitality: the tradition of the popular epic represented in the *romancero,* the learned tradition of Rome and of Renaissance Italy, and the tradition of Spanish life itself, which preserved, along with its Latin and Christian character, the influence of eight centuries of contact with Moors and Jews, an influence that has left its mark in the language, the proverbs, the poetic metaphors and songs, and also in certain mental and emotional habits of the Spanish people.

Many writers contributed their inventive, creative, and expressive capacity to the eminence of this period and it is undeniable that their originality was oriented and canalized by those unique mental and emotional habits to which allusion has already been made. In other countries the writer felt less prone to challenge or to criticize the society in which he lived, and the literature of England, France, and Italy about 1600 did not have as its primary theme the circumstances of contemporary life in these particular countries. The dramas of Shakespeare do not reflect directly the picture of English life in 1600; neither is the contemporary life of France spoken of in the dramas of Corneille and Racine. Outside of Spain the "literary epoch" and the actual epoch in which an author lived existed on different planes, at least in the most impressive forms of literary art. But in Spain the epoch of which the writer wrote and the epoch in which he lived have coincided on many eminent occasions. This contemporaneity had already been practiced in the *Poema del Cid* (1140), which never passes beyond the limits of its own time and in which the hero is at the same time poetic and historic; and in the greatest poetic work of the fourteenth century, the *Libro de buen Amor,* there are constant references to the life of Spain and to its cities, mountains, and rivers. An analogous phenomenon may be observed in the poetry of Juan de Mena and Jorge Manrique in the fifteenth century.

It is true that the literature of the sixteenth century some-

times continued the international orientation of Italian Humanism and did not mix poetry with the non-poetic life of the artist. The *Eglogas* of Garcilaso de la Vega thus refer to an abstract or generic world, and the same thing is true of the romances of chivalry of foreign origin, which are based on unreal history and geography. But this literary depersonalization did not produce the most perennial and universal values of the literature of Spain. We find these values almost always in works in which the plain spoken language and the Spanish land are intimately perceived and felt, and directly presented. So true is this that the plain fact that the characters in *La Celestina* seem to live in some late fifteenth-century Castilian city has given rise to an argument over whether the city is Toledo or Salamanca; similarly, *Lazarillo de Tormes* is inseparable from Toledo. It is not by chance, then, that the greatest work of this literature, the *Don Quixote* of Cervantes, is a most varied, complex, and effective vision of Spanish life at the end of the sixteenth century, represented equally in its smallest and in its greatest aspects. The same can be observed in the hundreds of plays composed by Lope de Vega, in which there is represented the fullness of Spain, its history from the Roman epoch to the days of the author; the manner of life of its peasants and kings, its cities, its intimate life, and thoughts; the sentiments, the clothing, the manners, and the grandeur as well as the miseries of the Spanish people. Tirso de Molina, Calderón, and other dramatists who continued to cultivate the dramatic genre invented by Lope de Vega also continued to reflect the concrete reality of the world in which they lived. This simple and evident fact enables us to see, on the one hand, the relation between literature and the form of life, and, on the other, permits us to understand how the literary genres developed by Spain and then transmitted to other literatures were possible.

The Spaniards are among the least objective of the European peoples, since only with difficulty can they separate what they do from what they feel and the circumstances which surround them. This fact is responsible for the lack of originality in Spanish philosophy and science, but it also accounts for the Spanish excellence in fiction. Even in the Middle Ages, the Spanish writer was already transforming the epic mythical personages that he had derived from foreign sources into historic, concrete, and present beings. The Cid of the *Poema* is a Castilian of the eleventh century set in the firm reality of his time, a reality familiar to those who heard the poem recited. The author, in fact, created the life of his personages in the image and likeness of his own life.

In this way, the generic personages of the traditional stories, or in general of any narrative, are converted into persons of flesh and bone. The readers of *La Celestina* saw in its main character a living person, and therefore any procuress is called a *celestina* in Spanish. Similarly, from the sixteenth century on, literary autobiographies are frequent, and a characteristic trait of the picaresque novel, initiated with *Lazarillo de Tormes,* is its autobiographical form, through the use of which the objectivity of narrative style is eliminated. The events are converted into the experiences of a life situated in the contemporary moment and in places which everyone knows. The same thing occurs in the religious literature. The medieval mystics speak of their divine emotions, and, through loving and desiring God, they aspire to be united with Him; but Teresa de Jesús wrote her autobiography in a very familiar style, related her most intimate experiences, and even included the sensations which she experienced in her body. Beneath the mystic, which is a generic type after all, there appears here the woman Teresa, born in Ávila, who travels in the cities of Castile as a concrete person, the contemporary of those who read her work in the sixteenth century; God and the spirit and body of Santa Teresa are here integrated in a manner that is particularly Spanish.

By virtue of this peculiarity of the Spanish character, the concept of the modern novel was appropriately developed in Spain with the *Don Quixote* of Cervantes. Before Cervantes, considerations of plot had largely determined the events occurring to, and the nature of, the characters of a story; in the *Quixote,* however, the events are generated by the protagonist himself as merely one aspect of the course followed by his life, and each of the authentic characters of the novel might be the nucleus for a possible autobiography.

Though in the novel the protagonist is shown influencing his own life and his own peculiar destiny, in the drama of Lope de Vega the characters exemplify rather the conflict between their spontaneous inclinations and what the ideals of Spanish society of the seventeenth century required of them. The Cid of Guillén de Castro's *Las Mocedades del Cid* ("The Youth of the Cid"), loves Jimena; but he must kill her father, who had insulted the Cid's father, because the idea of honor dominant in that society so required. Similarly, in *El Burlador de Sevilla* ("The Libertine of Seville") by Tirso de Molina, Don Juan challenges with his erotic passion the respect due to divine commandments and to social laws, and he is punished in spectacular fashion in order that his case may serve as an example. In such dramatic oppositions between passion and duty, the figure of the literary character becomes enormously more important; and it was because of such characters that the Spanish drama was diffused so successfully over Europe during the Baroque period of the seventeenth century, when the insecurity and the hesitation concerning the finalities of human life caused literature to shift its interest toward the problems of personal conscience. When such crises occurred, Europe more than once turned to the literature of Spain. Corneille thus found there the inspiration for the tragedy and the comedy inaugurated by him in France, and, in the same way, French fiction in the seventeenth century imitated or translated Spanish authors; in 1615 the French translator of the novels of Cervantes observed: "The Spanish possess something superior to us with regard to the order and the invention of stories."

Spanish personalism easily led also to the use of the autobiographical form, which, indeed, is inseparable from the Oriental tradition of the Peninsula. Antonio de Guevara speaks of himself in great detail in his *Epístolas,* and even the life of the Roman emperor Marcus Aurelius, a literary forgery of this period, is written in autobiographical form. Guevara was much read in France in Spanish and was translated into French, and the father of Michel de Montaigne enjoyed this reading a great deal. Furthermore, Montaigne's mother, Antonieta López, was of Spanish and Jewish origin, and it is therefore not strange that in such an atmosphere Montaigne should have conceived the autobiographical form of his famous *Essais,* a literary type which one would otherwise be surprised to find in the France of the sixteenth century. Another effect of the autobiographical urge in Spain that affected other European literatures is the analysis of one's own conscience, as practiced in the mystic works of Santa Teresa. This approach exerted a pronounced influence on the psychological literature of the seventeenth century.

**Decline and Rebirth.** Since the excellence of Spanish literature is particularly dependent upon subjective personal values and less upon objective political or economic vigor, it may happen that individuals of outstanding literary gifts will appear almost as often in epochs of national misery as in epochs of national security. It is true that the great period of

Spanish literature did occur at a time of great political power and economic prosperity, but this is by no means true of all important Spanish literary production. Thus, from the reign of Henry the Impotent (1454-1474) sprang the exquisite *Coplas* of Jorge Manrique, and between the seventeenth and eighteenth centuries, when Spain found herself almost isolated in Europe and when her culture had descended to the lowest level, there appears Feijoo, whose works are extraordinarily intelligent and surprisingly in tune with the science of his time. Somewhat later, at the end of the eighteenth century during the disastrous reign of Charles IV, we find a writer of the eminence of Melchor de Jovellanos and, to consider a related field, a genius of portrayal like Goya; after Ferdinand VII (1814-1833), when the country seemed but a shadow of itself and was torn by civil war, Spanish literature again reached a high level of excellence in the works of José de Larra, the Duke of Rivas, José de Espronceda, and other illustrious writers. So, in the dying Spain of the end of the nineteenth century, we have the extraordinary figure of Pérez Galdós. Finally, after the loss of the last Spanish colonies in 1898, everything pointed to a total eclipse of Spanish culture; but it is precisely during these last fifty years that there has occurred a literary rebirth, both artistic and scientific, rich in all kinds of values, and in contradiction to all the calculations and predictions of non-Spanish history. This phenomenon occurs in all fields of Spanish culture at this time. In literature Unamuno, Valle-Inclán, Azorín, Antonio Machado, and Baroja appear, among many others; in painting there are Sorolla, Zuloaga, and Picasso; in music, Albéniz and Falla; in science, Ramón y Cajal; in history and linguistics, Menéndez Pidal; and in philosophy, Ortega y Gasset and Zubiri. These men represent an aggregate of talent which would be sufficient to give dignity to any country; yet at the same time, twentieth-century Spain has suffered destructive political upheavals and bleeds with internal struggles. The case of Spain lacks analogy in the history of the modern world.

### THE LITERATURE OF SPANISH-AMERICA

Between 1810 and 1825, the Spanish empire in America, from Argentina and Chile north as far as Mexico, was fragmented into different republics. Cuba became independent in 1902. The language of these countries is Spanish, and in all of them the literature already initiated in the colonial epoch continued to be cultivated. Within this common tradition, the literature of Spanish-America offers regional peculiarities, just as in Spain a Galician element is perceived in Valle-Inclán and a Santanderian in Pereda. Similarly, the literary language of Spanish-America, is essentially the same as that of Spain in most instances, but in other cases, when local themes are involved, there appear certain peculiarities which vary as between Mexico and Argentina, Peru and Venezuela. The spoken language, moreover, as reflected in works of local inspiration, frequently contains both archaisms and native terms.

Spanish-American literature itself is very abundant and, at times, even excessive. Somewhat as in Spain, there is an irrepressible tendency toward diverting energy into literary channels. Thus, impulses which among other peoples have found expression in science, technology, industry, and many other kinds of social activities in Spanish-America have contributed rather to literary production. During a century of independent existence, this literature has shown a marked tendency to manifest the distinctive traits of each country. Argentina is distinguished by its preference for the theme of the gaucho, the countryman of the pampas, who has been idealized in multiple forms but has always been expressed in the language of rustics, as in the poem *Martín Fierro* of José Hernández and the novel *Don Segundo Sombra* of Ricardo Güiraldes. Similarly, the life of the Venezuelan countryside is found vividly described in the novel *Doña Bárbara* of Rómulo Gallegos. But together with this particularist tendency, there are also universal themes based on the feeling that Spanish America possesses a common meaning and destiny. Characteristic examples of this collective conscience are the works of the Ecuadorian Juan Montalvo, the Uruguayan José Enrique Rodó, and the Nicaraguan poet Rubén Darío, the last of whom the entire Hispanic world considers common property. Aside from these great figures, the most powerful personality is the Argentinean Domingo Faustino Sarmiento; among his abundant and sometimes hasty writings *Facundo* is outstanding, for here we can recognize the voice of a whole people that is conscious at the same time of its past, its present, and its future. In the highest moments of this literature, in Sarmiento, Darío, and Rodó, the common Hispanic notes of personalism, conflict between man and his destiny, and anxiety for eternity are clearly heard throughout the most varied and beautiful forms.

Spanish-American literature and thought, born in an epoch in which Spain found itself exhausted, were much influenced by the more vital nineteenth-century literature of France. French Romanticism and Naturalism thus inspired numerous Spanish-American novels and poems, and the positivist philosophy of Auguste Comte served as a gospel for the Spanish-American thinkers. During the twentieth century, however, and at the present time, an Hispanic reaction has occurred, and this has been accompanied both by the disappearance of many Gallicisms current in the language of the preceding century and by the renewed influence of Spanish thought, especially in Unamuno and Ortega y Gasset, and Spanish poetry. But there has also been a movement towards internationalism; the literatures of England, North America, Russia, and other countries are broadening the range of Spanish-American writers, and new problems characteristic of international thought have been discussed in the works of the Mexican Antonio Caso, the Argentinean Francisco Romero, and the Uruguayan Carlos Vaz Ferreira. A. C.

**SPANISH MUSIC.** The traditional music of Spain is characterized by regional variety, by strongly marked and often complex rhythms, and by certain exotic melodic and harmonic traits resulting from the divergent cultural and ethnic strains that have fused in the Iberian peninsula. The folk music of Andalusia, in the south, appears to have been influenced by such diverse factors as the ornamental style of the ancient Byzantine chant, the Arabian scales and melodies implanted during the Moslem occupation, the music of the gypsies who migrated to Spain from the fifteenth century onward, and the Hebrew synagogical chant. Out of these developed the type of Andalusian folk singing known as *cante jondo,* or "deep song," and its more modern derivative called *cante flamenco.* Other typical examples of regional folk music are the *seguidillas* of Castile, the *alalá* of Galicia, the *zortzico* of Biscay, the *sardana* of Catalonia, and the *jota* of Aragon. The *bolero,* another well-known dance, has many regional variants. Modern Spanish composers, as well as composers of many other nationalities, have drawn extensively on the rich store of Iberian folk music. Before dealing with the modern national movement, however, it will be advisable to survey briefly the historical development of Spanish music.

**The Middle Ages.** From 711 to 1492 a large part of

Spain was occupied by the Arabs and Moors, who overthrew the Christian Visigothic monarchy and implanted much of their culture in the Iberian peninsula from an early date. The treatise on music written by the Arab philosopher Farabi (870-950) did much to spread the influence of the Arab style of music throughout the peninsula. Later, Arabian or Moorish musicians were employed even at the courts of the Spanish kings, as that of Alfonso X of Castile and León (1221-1284), called "the Wise." This scholarly and music-loving monarch directed the compilation of the *Cantigas de Santa María,* a collection of over four hundred songs in praise of the Virgin Mary, which comprises one of the most notable musical monuments of the Middle Ages. The slightly earlier *Codex Calixtinus,* dating from the twelfth century, preserves the Latin hymns that were sung by pilgrims to the celebrated shrine of Santiago de Compostela. Also important both historically and musically are the pilgrim songs of another famous shrine, Montserrat, in Catalonia, dating from the fourteenth century and contained in the so-called *Llibre Vermell.*

**The Renaissance.** The important musical manifestations during the Renaissance were religious polyphony in choral music for the church, secular part-songs, solo songs, organ music, and music for the guitar or the lute. The secular part-songs are preserved chiefly in the *Cancionero de Palacio* ("The Palace Songbook"), a collection of nearly five hundred songs composed between approximately 1470 and 1525. The outstanding composer represented in this collection is Juan del Encina (1469-1529), poet, playwright, and musician, whose eclogues, or pastoral plays with singing and dancing, constitute the foundation of the lyric theatre in Spain. Music for the *vihuela,* a kind of lute, and solo songs with instrumental accompaniment are found in various music books printed during the sixteenth century, notably those of Luis Milán, Luis de Narváez, Alonso de Mudarra, and Miguel de Fuenllana. These composers were pioneers in developing the theme with variations as an instrumental form; often their variations were on Spanish folk tunes. Antonio de Cabezón (1510-1566) was the leading organist and composer for organ of this period, while Juan Bermudo, Bartolomeo Ramos de Pareja, and Francisco de Salinas wrote valuable treatises on music. Religious music reached its apex in the works of such composers as Cristóbal de Morales (c. 1500-1553), Francisco Guerrero (c. 1527-1599), and Tomás Luis de Victoria (c. 1548-1611), who is generally regarded as Spain's greatest composer. Because of the creative genius of these masters, the period in which they lived has since come to be known as the Golden Age of Spanish music.

**Baroque and Rococo.** Victoria's last work, the *Officium defunctorum* ("Office for the Dead") for six-part chorus, foreshadowed the more elaborate style of the Baroque period, which in Spain found its most characteristic musical expression in the religious music of Juan Bautista Comes (1568-1643), full of grandiose effects and violent contrasts. The Baroque period was marked by a shift of emphasis from the church to the theatre, however, and this led to the emergence of opera. The text of the first Spanish opera, *La Selva sin amor* (1629) ("The Forest Without Love"), was written by the famous dramatist Lope de Vega, but the composer of the music is unknown. The earliest Spanish opera for which the music has been preserved, at least in part, is *Celos aun del aire matan* ("Even Baseless Suspicions Kill"), with a libretto by the eminent dramatic poet Calderón de la Barca and a score by Juan Hidalgo, who also wrote music for several other plays by Calderón. In the eighteenth century the leading dramatic composers were José Nebra, who also wrote much religious music, Sebastián Durón, and Antonio Literes. Instrumental music is represented by the vivacious harpsichord sonatas of Antonio Soler (1729-1783), a pupil of Domenico Scarlatti. Soler also composed church music and some admirable quintets for strings and organ.

**The Nineteenth Century.** Spanish composers of the nineteenth century were largely concerned with developing a national opera. Many of them cultivated the *zarzuela,* a type of opera that was generally comic and contained spoken dialogue. Notable among these composers was Francisco Asenjo Barbieri (1823-1894), whose most famous *zarzuelas,* full of vivid local color, are *Pan y Toros* ("Bread and Bulls") and *El Barberillo de Lavapiés* ("The Little Barber of Lavapiés"). Other major composers were Joaquín Gaztambide y Garbayo, Rafael Hernando y Palomar, Cristóbal Oudrid y Segura, Emilio Arrieta y Corera, Fernández Cabellero, Federico Chueca, Ruperto Chapí, Tomás Bretón y Hernández, and Amadeo Vives. Felipe Pedrell (1841-1922) had more extensive plans and both collected the folk music of Spain and published the neglected masterpieces of the Golden Age. He was not entirely successful in his attempt to create a national lyric drama, but he became the leader of the next generation of composers, who achieved the modern renaissance of Spanish music.

**The Twentieth Century.** Pedrell preached the doctrine that each nation should build its art music on the foundation of its native folk songs and dances, and this doctrine led to the rise of a nationalist school of composers, among whom the most prominent were Isaac Albéniz (1860-1909), Enrique Granados (1867-1916), Joaquín Turina (1882-1949), and Manuel de Falla (1876-1946). Albéniz and Granados wrote mostly piano music; the former's masterpiece is the twelve-part suite *Iberia,* while the latter is remembered for his Spanish dances and the suite *Goyescas,* later made into an opera of the same title. Turina wrote colorful piano pieces as well as effective orchestral works such as *La Procesión del rocío.* Falla, considered the greatest of modern Spanish composers, achieved fame with an opera, *La Vida breve* (*Life Is Short*), the evocative tone-poem for piano and orchestra, *Noches en los jardines de España* (*Nights in the Gardens of Spain*), and the ballets *El Amor brujo* (*Love, the Magician*) and *El Sombrero de tres picos* (*The Three-Cornered Hat*). G. C.

**SPANISH SAHARA,** also called Rio de Oro, a region under Spanish control on the northwestern coast of Africa. Including the southern zone of Spanish Morocco (as the term sometimes does), Spanish Sahara is bounded on the north by French Morocco and on the east and south by Algeria and French West Africa, and is divided into three sections: the southern zone of the Spanish protectorate in Morocco, Saguiet el Hamra (Sekia el Hamra or Saguia el Hamra), and Rio de Oro. Often only the latter two zones are considered to comprise Spanish Sahara, or Rio de Oro, since the northernmost comes under the nominal jurisdiction of the Sherifian empire (French Morocco and Spanish Morocco). The northern section extends south from French Morocco to 27° 40′ N. lat.; Saguiet el Hamra lies between this meridian and Cabo Bojador at 26° N. lat.; and Rio de Oro, the name applied to the southern section as well as to the entire territory or the two southern sections, extends south from Saguiet el Hamra to 21° 20′ N. lat. and includes also the western half of Cap Blanc (Cabo Blanco) Peninsula south of that line. The combined area is about 109,200 sq. mi., and the population was estimated at 37,000 in 1950.

The terrain is low and desertic, with the Sahara coming down to the water's edge along this section of the Atlantic coast. Rainfall is negligible and irregular. There are no streams, merely wadis or dry runs. A few scattered oases and wells are to be encountered, but not enough to give rise to any significant agricultural activity. The sparse and tough vegetation of this desolate region supports some stunted cattle and a small number of camels, sheep, and asses, which constitute the principal resources of the nomadic tribes. These tribes represent a mixture of Arab, Berber, and Negro elements. Nominally they profess Islam, but their tenets and practices are hardly orthodox. Their social and economic organization is distinguished by a division into four castes which are clearly marked.

Towns are few and quite small. The chief ones are Cabo Yubi, Smara, and Villa Cisneros, the administrative centers respectively of the southern zone of the protectorate, Saguiet el Hamra, and Rio de Oro; and Puerto Cansado and La Aguera. All except Smara are on the coast. At Cabo Yubi and Villa Cisneros airports were constructed before World War II to serve air traffic on the route between Europe and South America. There are no ports of any importance, and only an infinitesimal amount of exports or imports.

In appearance, if not in actuality, the administration of Spanish Sahara is complicated by the fact that it is divided into three sections, one of which nominally forms part of the Sherifian empire of Morocco. For example, the khalifa, the sultan's deputy in the two Spanish-controlled zones of Morocco, has a majzen headed by a grand vizier, who in turn is represented at Cabo Yubi in the southern zone by a delegate and various lesser officials. In reality, the khalifa and his subordinates are responsible only to the Spanish high commissioner, who is in charge of governing all parts of Spanish Sahara. The actual administration is carried on by subordinate officials, whose principal seat is at Cabo Yubi. Order is maintained over the barren vastness of Spanish Sahara by a camel corps and a small air force.

Spain's interest in this section of the Sahara was first shown early in the sixteenth century when it was motivated by a desire to protect its newly acquired holdings in the Canary Islands, the inhabitants of which had already become accustomed to hunt slaves on the near-by mainland. But the original urge to colonize the area soon subsided and Spain allowed its claims to lie dormant until after the war with Morocco in 1859-1860. During the scramble for Africa in the 1880's, Spain obtained the submission of tribes over extensive areas in southern Morocco and on the Sahara coast. Villa Cisneros was established in 1885. However, France intervened, and by a series of agreements culminating in that of Nov. 27, 1912, Spain was obliged to reduce its claims substantially to within the present frontiers. Cabo Yubi was occupied in 1916 and La Aguera in 1920. *See also* Rio de Oro; Spanish Africa.

R. G. W.

**SPANISH SUCCESSION, WAR OF THE** (1701-1714), the last of many conflicts resulting from the efforts of Louis XIV of France to increase his authority and influence in Europe. The immediate cause, which gave a name to the struggle, was the acceptance of the Spanish crown by Philip V, grandson of Louis, in February 1701. Arrayed against France and Spain were England, Holland, and Austria. The claimant of the Spanish crown supported by this coalition was Charles, second son of the Emperor Leopold I. Many other states, Portugal, Bavaria, Cologne, and Savoy among them, either were dragged into the war or entered for selfish reasons. Fear of France, however, was the compelling motive of those opposed to a Bourbon king of Spain. Their position was that of defense of the doctrine of the balance of power, which was held to be a guarantee of peace and an essential basis of international law. The only common people interested in the outcome were those of Spain. The Castilians supported Philip against the armies of invading foreigners. The Catalans supported Charles because Philip threatened to deprive them of their local liberties. In the later years of the war (1708-1713), when the armies of Louis were forced to defend France from invasion, the French began to support their monarch actively. For the rest of Europe, however, this was a war of rulers, using mercenary troops. It was conducted in accordance with the rules of the day which demanded economy and extreme caution. Other obstacles to a decisive action were lack of harmony among the allies, ignorance and lethargy of many of the commanders, and lack of steady support by the home governments. Students of military science find excellent material in the campaigns of Marlborough, Eugene, Villars, and Vendôme. On the whole, however, the war was a dreary succession of stalemates, disappointments, and reverses. Naval operations were little more impressive. Great Britain's navy kept the war alive in Spain on both the Portuguese and the Catalonian fronts. One Spanish treasure fleet was captured. Gibraltar and Minorca were taken and held by Great Britain. The more important campaigns on land were fought in Flanders, the Palatinate, the upper Danube, the Po valley, and in Spain. In April 1711, the Emperor Joseph I died, leaving his domains to Charles. Since a union of Spain and Austria was also a challenge to the doctrine of the balance of power, and even more dangerous to Bavaria, Savoy, and Cologne than the union of France and Spain, the opponents of Louis XIV commenced negotiations which led, in 1713, to the Peace of Utrecht. France and Austria continued the war for another year, finally settling their differences at the peace of Rastatt.

J. J. Van N.

**SPANISH TRAGEDY, THE** (c.1585), a blank-verse tragedy by Thomas Kyd, was one of the most influential and continuously popular plays of the Elizabethan theatre. Against the pseudo-historical background of a war between Spain and Portugal, it recounts the rivalry between Balthazar of Portugal and Horatio, son of Hieronimo, marshal of Spain, for the hand of Bel-Imperia, niece of the Spanish king. Through the ambitious scheming of Bel-Imperia's brother, Lorenzo, Horatio is murdered. The remainder of the action presents Hieronimo's pursuit of justice and revenge, culminating in his staging of a play in which suitable disposition is made of all the chief characters. Kyd's tragedy was a sensational success. Adapting many features of Senecan drama to the uses of theatrical spectacle, it established the basic principles and practices of Elizabethan tragic technique and was responsible for launching one of the most important Elizabethan dramatic genres, the tragedy of revenge.

H. R. W.

**SPARAXIS** [spəræ'ksɪs], commonly known as the wandflower, a genus of the iris family which has three species native to the Cape of Good Hope. The plant, from 1 to 2 ft. high, grows from a corm, or solid bulb, and has lance-shaped leaves 6 to 10 in. high, arranged in a basal rosette. The flower stems, of the same height, bear one, or occasionally more, 6-petalled, funnel-shaped flowers in a wide range of bright colors and markings. In California and in the South, sparaxis may be grown outside for spring blooming. In cold climates, wandflowers are grown under glass as pot plants.

J. C. Wis.

**SPARKS, JARED** (1789-1866), historian, educator, and editor, was born in Willington, Conn., May 10, 1789. He graduated from Harvard in 1815, and while teaching there, 1817-1819, he also edited the *North American Review*. He went to Baltimore, where he served as pastor of a Unitarian Church from 1819 to 1823 and also as chaplain of the United States House of Representatives from 1821 to 1823. His principal interest, however, was in historical research and writing. He returned to Boston, where he became owner and editor of the *North American Review* from 1823 to 1831. He made it one of the most important periodicals in America, comparable with similar publications in Europe. As editor of the magazine, and in his later editing of the writings of noted men, Sparks revealed a serious editorial weakness, fear of offending the mighty.

He became interested in the American Revolution, for, as he once said, no complete history had yet been written of that important period. He never wrote his projected work, but he published *The Writings of George Washington,* 1834-1837, 12 volumes, *The Diplomatic Correspondence of the American Revolution,* 1829-1830, 12 volumes; *The Works of Benjamin Franklin,* 1836-1840, 10 volumes; and *Correspondence of the American Revolution, Being Letters of Eminent Men to George Washington,* 1853, 4 volumes. Between 1834 and 1838 Sparks edited 10 volumes of *The Library of American Biography* and a second series of 15 volumes between 1844 and 1847. Of the total of 60 biographies in these two series, Sparks wrote eight. Although he was not an accurate editor, amending and deleting passages in his source material, he opened large areas for historical research. His biographies of Washington and Franklin were widely read. Sparks was McLean Professor of History at Harvard from 1839 until 1849, when he became president of the university, serving in this capacity until 1853. He died at Cambridge, Mass., Mar. 14, 1866. M. K.

**SPARKS,** a city in western Nevada, an important railroad division point, situated in Washoe Co., 3 mi. east of Reno. The surrounding agricultural area is noted for its onions, potatoes, and hay, and gold and silver are natural resources of the area. The city has the mayor-council form of local government. Sparks was founded in 1905 by the Southern Pacific Railroad, which moved houses to the site from another locality where it had been carrying on construction. It was named after John Sparks, then governor of Nevada. The railroad shops maintained by the Southern Pacific Railroad are the chief industry. Pop. 1950, 8,203.

**SPARROW,** in the strict sense, any one of a large number of species of small songbirds combined in the genus *Passer* of the family Ploceidae or weaverbirds. Less exactly, the name sparrow is applied in the United States and Canada to a great variety of finches in the family Fringillidae, which properly should be known as buntings. The true sparrows are widely distributed in the temperate and tropical regions of Europe, Asia, and Africa. The best-known species, *P. domesticus,* the house or English sparrow, which originally ranged from the British Isles to Burma, was artificially introduced into the United States in 1850 in Brooklyn, N. Y. It was also released into Australia, New Zealand, Argentina, and the Hawaiian Islands and is now abundant in all of these countries. This bird is too well known to require a description; its relatives bear a close resemblance to it in pattern and often in coloration, although some of the tropical species wear yellow and chestnut in place of gray and brown, and some desert-dwelling forms are mainly sandy gray. Technically classed as singing birds, they have chattering and unmusical voices. Their nests are untidy structures built in holes and crevices, often under the eaves of occupied houses. H. G. De.

SONG SPARROW, MELOSPIZA MELODIA

FROM A DRAWING BY L. A. FUERTES

COURTESY OF THE U. S. FISH AND WILDLIFE SERVICE

**SPARTA** [spɑ′rtə], the leading city of Laconia, the southeastern part of the Peloponnesos, and the purest Dorian of all the states of ancient Greece. Ancient Sparta was situated on the west bank of the Eurótas River and extended northward from the modern town of Sparta. The term "Lacedaemon," was applied to the Eurótas Valley, and the term "Lacedaemonians" was often used for the inhabitants of this area.

Sparta, which has a name that may mean "scattered," was composed of homes and estates scattered about an area centering on a low hill that has come to be called the Acropolis. It was originally an unwalled town; it remained so until after 200 B.C. The modern visitor is frequently disappointed by the scanty remains of the famous and once powerful state, but even when the power of Sparta was at its height, the traveler would not suspect from such buildings as he saw, that he was in a great city-state. The excavations by the British School at Athens, conducted from 1906 to 1910, have brought to light the remains of several buildings, notably the sanctuary of Artemis Orthia, the temple of Athena-of-the-Bronze-House, and the theatre. The theatre was of white marble, and according to Pausanias, who described the buildings of Sparta about A.D. 160, it was "worth seeing"; but this stone structure was of Roman date. From the low Acropolis a fine view is afforded of the Eurótas Valley, with its extensive olive orchards, and of the lofty range of Mt. Taygetus, steeply rising to the height of 8,000 ft. to form the western boundary of the Sparta domain.

Sparta was of comparatively late origin, having been established only after the "Dorian Invasion," the last wave of Greek people to enter Greece, which brought an end to the Bronze Age between 1150 and 1100 B.C. At first the newcomers may have lived at or near the sites of the towns that they had captured and often destroyed, but within a century the conquerors had established their "capital" by the Eurótas River, a few miles north of the strong pre-Dorian town of Amyclae, and almost two miles west of Therapnae, another Helladic or Mycenaean city.

Amyclae, the most important city in Laconia during the Bronze Age, wherein was found the "beehive" tomb from which the famed gold Vaphio cups were recovered, apparently did not fall immediately to the Dorian invaders but held out for possibly two or more centuries. Eventually, through a *synoikismos* ("housing together"), Amyclae was amalgamated with other regions to form the Sparta state.

Since Sparta was not in existence at the time of the traditional Trojan War (c. 1200 B.C.), the legend of the abduction of Helen by Paris from King Menelaus of Sparta must have been transferred to Sparta from some other site after Sparta had risen to prominence. At Therapnae, the site of an extensive Mycenaean or Bronze Age city before 1100 B.C., there was a sanctuary called the "Menelaion" where the cult of Menelaus and Helen was carried on down into Classical times.

An increase in population attended by related economic and social problems, led Sparta to adopt a policy of expansion. Aside from the colonization of Tarentum in Italy in the eighth century, Sparta restricted her political expansion to Greece proper. Messenia, to the west of Laconia, was conquered in the course of the First and Second Messenian Wars, variously dated between 725 and 600 B.C., and the Messenians were reduced to the status of Helots, or Spartan serfs. Indicative of the expansion of Sparta is the tradition that the Eleans were enabled, by the help of Sparta, to regain from their rival, Pisa, the control of the Olympic Games. The first recorded Spartan victory at Olympia was that of Acanthus in the long-distance race, about 720 B.C. For over a century the Spartan athletes were conspicuous for their victories at Olympia, winning in this period forty-six of the recorded eighty-one victories.

Aside from wresting some territory from Argos and from Arcadia, Sparta for the most part turned from conquest to the acquisition of power by treaties with various states. Sparta, as the head of the Peloponnesian League, actually dominated all of the Peloponnesos except Argos and Achaia, on the northern coast of the Peloponnesos, and by 550 B.C. had become the greatest military power in Greece. Thus there was an organized force to form a bulwark against the threatening Persian aggression, and the united efforts of the Peloponnesian League and of Athens and her allies brought about the decisive victories over the Persians at Salamis and Plataea in 480 and 479 B.C.

It was inevitable that the two great powers of Greece, Dorian Sparta and Ionian Athens, the land power and the naval empire, should come into conflict, and the Peloponnesian War broke out in 431. Eventually, in 404, Sparta, aided by such circumstances as the plague, blunders, and imperialistic over-expansion, brought an end to the Athenian empire. Sparta, however, proved to be a harsher master than Athens; discontent with Spartan hegemony led to more war, and Sparta lost her position as leader of Greece. Led by Epaminondas, the Thebans and their allies inflicted decisive defeats on the Spartans at Leuctra (371) and at Mantinea (362), and, except for spasmodic outbursts of force and occasional periods of power, Sparta declined thereafter and never recovered her former power and prestige.

Soon after 200 B.C., the "tyrant" Nabis built a wall around Sparta, and the theatre was built of stone. During the Roman period, beginning in 146 B.C., Sparta became a large and prosperous provincial city, and fortifications and other buildings were erected. Until about A.D. 350 Sparta flourished, though as a smaller and less consequential city than before. In A.D. 396 the city was destroyed by Alaric. The Spartan customs and "discipline" continued until the city's fall, and visitors came to watch the annual endurance contest, the flogging of the young Spartans, which continued to be held as of old at the sanctuary of Artemis Orthia by the Eurótas. Historically, Sparta was greatest from approximately 700 to 400 B.C.

Of considerable importance in world history is the influence exerted by the political and social system of Sparta. At the head of the Spartan state were two kings, one of the family Agidai, the other of the Eurypontidai. The origin of the dual kingship may be sought in a compromise effected after the two tribes had come to an impasse, each demanding that one of their clan should rule as king. The two kings sat with the Gerousia, "Council of Old Men," composed of twenty-eight men over sixty years of age, who were elected for life. The Apella was the popular assembly, to which were elegible all true Spartans who had attained the age of thirty and could maintain and equip themselves in the prescribed manner. Of later origin was the ephorate, a commission of five officials elected by the Apella, one from each of the five geographical divisions of Sparta. The five ephors, possibly as a consequence of Chilon's term of office (c. 555 B.C.), came to have powers greater than those of the two kings. To prevent insurrection on the part of the numerically superior Helots, a secret police force, the Krypteia, was continually active.

Strangely enough, the type of civilization now widely known as Spartan was not characteristic of early Sparta. British excavations have confirmed the theory, advanced by historians on literary grounds, that the civilization of Sparta before 600 B.C. was essentially on a plane with that of contemporary Athens and other Greek states. The remains of sculpture, the fine Laconian pottery, and the ivory, bronze, lead, and clay figurines found at the site bear witness to the quality of Spartan civilization, as do the poetry of Tyrtaeus and Alcman, of the seventh century. But soon after 600 B.C. an abrupt change took place. Art and poetry disappeared, and the names of Spartans ceased to figure among the names of victors at Olympia. Before the change was felt, about 600, the Spartan Gitiadas built the "Bronze House" of Athens; some fifty years later, in contrast, the foreign artists Theodorus of Samos and Bathycles of Magnesia were imported to build, respectively, the Skias at Sparta and the temple at Amyclae. Sparta was suddenly transformed into an armed camp, and the resulting military state henceforth produced only soldiers. The system that fostered this way of life is traditionally ascribed to Lycurgus, but whether Lycurgus was a god, a mythical figure, or an historical person, is undetermined. Even the time of his institution of Spartan discipline is not known, the date given to him ranging from the eighth century to the first half of the sixth century B.C. At any rate, this strict system was instituted, possibly between 590 and 580, not through fear of foreign aggression, but because of internal conditions.

The Spartan state was composed of three classes, the *Spartiatai* or true Spartans, the *perioikoi* ("dwellers-around"), made up of the inhabitants of federated towns that encircled the Spartan domain, and the Helots. Only the *Spartiatai* were privileged to vote and share in the government. They were forbidden to engage in trade, and the introduction of cumbersome iron money was designed to discourage their entry into business. Their landed estates, worked by Helots, were supposed to yield sufficient income to provide them with military equipment and to support their daily needs. The *perioikoi* carried on the necessary trade and industry of the country. They could not engage in the political life of Sparta, but they had certain rights, as well as the doubtful

privilege of serving in the army. With a vast number of Helots to carry on the daily work, the Spartan was able to devote his entire time to physical and military training.

It has been estimated that about 600 B.C. there were approximately 25,000 citizens, 100,000 *perioiḳoi,* and 250,000 Helots. Later on, the Spartans came to be outnumbered by the Helots fifteen to one. Wars and economic conditions reduced the number of *Spartiatai.* In the Persian Wars ( c. 480 B.C.) Sparta sent about 5,000 soldiers into the field, but a century later, in 371, only 2,000 Spartans fought in the Battle of Leuctra. In the third century it appears from a contemporary account that Sparta had only about 700 citizens.

It was, evidently, to maintain their position at the head of the State that the ruling Spartans felt it necessary to constitute themselves into a great standing army. The State came to control the life of the citizen from birth to death. The State decided whether the child at birth gave promise of becoming a healthy citizen or whether he should be exposed on Mt. Taygetus. The boy's first years at home were marked by privation and discomfort to toughen him for life. At the age of seven his training was taken over by the State, and his time was devoted almost exclusively to physical exercise and military drill. At the age of twenty the young Spartan joined a *syssition,* or "mess-group" of fifteen boys, and continued his military exercises and drill. He could marry, but only by stealth could he visit his wife. At the age of thirty he became a mature man and was privileged to attend the Apella, but his time was mostly spent at the gymnasia, clubs, and *syssition.* Thus the life of every Spartan was practically the same as that of every other, and war came as a welcome break in the monotonous military routine. The Spartan's gravestone bore only his name, unless he was killed in war, in which case the phrase "in war" was added to the inscription.

Spartan girls also underwent athletic training, engaging in running, jumping, wrestling, and the throwing of the discus and the javelin. Lycurgus is said to have instituted this training of girls in order that they might become strong and brave women, productive of a vigorous, healthy offspring.

The Spartans deliberately instituted their self-imposed despotism, a strict form of socialism, which robbed the individual of all freedom and initiative, and wiped out the beneficent influences of family life; yet the Spartan way of life appealed strongly to Plato, who incorporated many of its military, totalitarian, and communistic features in his ideal state. In modern times, Spartan discipline has often been taken as a model by totalitarian states in times of peace and war, and by some democracies in time of war. Thus, though Sparta long ago lost its political power, its political and cultural ideology, in some lands and at some times, continues to be of significance. J. P. H.

**SPARTA,** a city and summer resort in west central Wisconsin, the county seat of Monroe Co., situated on the La Crosse River, 26 mi. northeast of La Crosse. Founded about 1850, Sparta was made the county seat about 1855. The community has the mayor-council form of government. Sparta is the seat of a state school for dependent children, and 5 mi. from the city is located Camp McCoy, an army training camp. Sparta is an important market for the leaf tobacco raised in the vicinity and a shipping point for the region's berries, dairy products, and poultry. Transportation is furnished by the Chicago and North Western and the Chicago, Milwaukee, St. Paul and Pacific railroads. Local industries manufacture pumps, sewer equipment, brushes, and condensed milk. Pop. 1950, 5,893.

**SPARTACUS** [spa′rtəkəs], Thracian gladiator who organized a revolt of gladiators and slaves in Italy in 73 B.C., an uprising that was joined by runaways from the great estates in southern Italy. The insurgents took refuge on the slopes of Mount Vesuvius and at length became so numerous that they were able to defeat two Roman armies (72 B.C.). Spartacus was finally defeated and killed by Marcus Licinius Crassus in 71 B.C. The followers of Spartacus who escaped Crassus were intercepted and annihilated in northern Italy by Pompey, who was just returning from his victory over Sertorius in Spain. T. B. J.

**SPARTANBURG** [spɑ′rtənbɜrg], a city in northwestern South Carolina, the county seat of Spartanburg Co., located 80 mi. northwest of Columbia in the foothills of the Blue Ridge Mountains. Cotton and peaches are the chief crops of the surrounding region. In 1785 Thomas Williamson donated two acres of forest land to found the county. The county and the community which grew up subsequently derived their name from the Spartan Regiment, the popular name of the South Carolina militia, which distinguished itself in the Revolution. The battlefields of Cowpens and Kings Mountain, Revolutionary battles, are near by. The community's cotton industry dates back to 1816 when the first two cotton mills were established. Spartanburg was incorporated in 1831. During the Civil War its industries supplied arms and textiles to the Confederacy. After the Civil War the city's iron works diminished in importance, and the textile industry ascended to first place. In 1919 Camp Wadsworth, where the 27th, 6th, and 9th divisions were trained during World War I, was returned to the city, and part of it was designated as a memorial park. Spartanburg is the seat of Converse College for women and Wofford College for men. Near by is a state school for the deaf, dumb, and blind. Transportation is supplied by the Southern, the Charleston & Western Carolina, the Clinchfield, and the Piedmont and Northern railroads. Air service is maintained by the Delta and Eastern air lines. Spartanburg is one of the country's leading textile centers. In 1945 there were 42 cotton mills in the city and its immediate vicinity. In addition, there are flour and grist mills and railroad shops. The varied factory output also includes fertilizer, machinery, cottonseed products, lumber, and creosote. Pop. 1950, 36,795. A. W.

**SPARTEL** [spɑrtɛ′l], a cape forming the northwestern corner of Africa. It may be said to mark the point where the Strait of Gibraltar and the Atlantic Ocean meet. Known to the ancients as Ampelusium, Cape Spartel is 6 mi. west of Tangier in the International Zone of Morocco. The view from the promontory is spectacular and is an attraction to tourists. An international lighthouse, built in 1860, surmounts the cape. R. G. W.

**SPARTIVENTO, CAPE** [spɑ′rtivɛ′nto], known to the ancients as Promontorium Herculeum, a promontory 156 ft. above sea level marking the southernmost point in Calabria, and hence in continental Italy. It is surmounted by a lighthouse with a beam visible for some 30 mi. The waters around Cape Spartivento are noted for their roughness and shoals. R. G. W.

**SPATTERDOCK,** a common perennial herb, *Nuphar advena,* found in quiet streams or ponds, also known as yellow pond lily or cow lily. It ranges from Georgia to

Texas, Nebraska, Wisconsin, and New York. Large heart-shaped leaves, floating or erect, rise on spongy leaf stalks from the summit of the thick fleshy rootstocks. The yellow globular flowers, sometimes tinged with purple, are borne above the surface of the water and bloom all summer. The rootstocks of *N. advena* and seeds of the western species, *N. polysepalum,* have been used by the Indians as food. Spatterdock is also the common name of certain aquarium plants. One species of the latter, *N. japonicum,* is native to Japan and Asia. A. Gr.

**SPEAR.** *See* Arms and Armor (*Shafted Weapons*).

**SPEAR GRASS,** a perennial grass, *Stipa elegantissima,* native to Australia and often cultivated for its loose and feathery panicles of flowers. The grass grows as high as 3 ft. and thrives in sandy soils. It is closely allied to porcupine grass, *S. spartea.* J. C. Wis.

**SPEARMINT,** an aromatic perennial herb, *Mentha spicata,* of the mint family, closely allied to the peppermint. It yields an essential oil much used in flavoring. Spearmint is a native of Eurasia, grown since ancient times as a culinary herb, which has become widely naturalized on moist ground throughout North America. The smooth, erect, branching stems, 1 to 2 ft. high, bear narrow, sharply toothed leaves and purplish flowers in slender, interrupted spikes. R. P. T.

**SPECHT, FRANZ** [shpɛ′χt] (1888-1949), German linguist, was born at Rosslau in Anhalt on Nov. 1, 1888. He studied at the Universities of Leipzig and Berlin and in 1918 obtained his Ph.D. at Leipzig. In 1923 he became professor of Indo-European linguistics at the University of Halle, in 1937 at Breslau, in 1943 at Berlin, and in 1946 at the University of Mainz. He died on Nov. 13, 1949.

Specht's career began with his edition (1922-1924) of A. Baranowski's collection of Lithuanian dialect texts. His introduction to this work, which treated of Lithuanian grammar and contained a valuable historic linguistic commentary, laid the foundations of Lithuanian dialectology. In 1924 he contributed a collection of Latvian and Lithuanian fairy-tales, in German translation, to the series *Märchen der Weltliteratur.* Thereafter he began publishing, in the *Zeitschrift für vergleichende Sprachforschung,* a series of important treatises which shed light on Indo-European phonology and morphology, on prehistory as illustrated by linguistic data, and on the different layers of Indo-European development. These bear witness to Specht's wide range of exact and intimate knowledge of the history of all the important Indo-European languages.

Specht's major work on the origin of Indo-European declension (*Der Ursprung der indogermanischen Deklination,* 1944) is an attempt to elucidate the morphology of the language of the early Indo-European period by analyzing the word formation of the Indo-European languages. In its first part, on the Indo-European declension as a reflection of Indo-European civilization, Specht investigates the inflection of words that designated familiar objects and finds that these words in general had an irregular inflection, not that of the *o-* or *ā-* stems. In the second part, treating the origin and growth of Indo-European declension, he concludes that the word elements that follow the root of a word and are also found in the declensional cases were originally demonstrative pronouns, which came to be added to the root; these pronouns originally indicated place or direction in space. Specht's far-reaching conclusions are not accepted by all, but the wealth of his material and the excellence of his powers of interpretation and analysis make his work a stimulus and a source of information to scholars. F. M.

**SPECTATOR, THE.** *See* Addison, Joseph; Essay.

**SPECTRA, STELLAR AND SOLAR.** Stellar spectra are the main key to the secrets of the stars and, as such, are of inestimable value to the knowledge of the universe. They are mainly of the dark-line type, only a small proportion of stars showing a bright-line spectrum. In accordance with the laws of spectroscopy, the spectral lines determine the elements of matter contained in the distant body, and also demonstrate motions of the bodies themselves.

**Stellar Spectra.** Stellar spectrograms are made in two ways: (1) A prism may be placed over the objective of a photographic refractor. This gives spectra of many stars on one negative and is used for purposes of classification. A special filter in front of the plate introduces particular spectral lines for orientation of the stellar spectra. (2) A spectroscope may be used at the eye-end of the telescope, with photo attachment. This has either prisms or a grating of parallel lines, and the slit of the instrument is at the focus of the telescope. A comparison spectrum from a laboratory source is thrown onto each side of the star's spectrum. This second method is of value for individual studies of stars.

Spectra from countless millions of stars can be classified in a small number of categories. There are seven main groups in the classification begun by Henry Draper at Harvard. They are named after the letters O, B, A, F, G, K, M. The last six include the greater proportion of all stars. The first six are the bluish stars; the *M*-stars are red. The classes *R, N,* and *S* have been added at the end, *R* and *N* being "side issues," and the *S*-stars a special class. It is notable that there is a continuous graded series of spectra, with transitions between groups. The special significance of the continuous feature is that difference in the spectral pattern is probably caused by difference in one physical feature in the stars, that is, temperature.

**Solar Spectrum.** The sun's spectrum is a band of beautiful colors from red to violet, crossed by thousands of dark (Fraunhofer) lines. Prominent lines have letters assigned them, such as the yellow *D*-line of sodium, with a wave length of 5893 Angstrom units. Fraunhofer lines mostly represent wave lengths "abstracted" from solar light by cooler gases around the sun. Certain lines in the sun's spectrum do not originate in the sun but in the earth's atmosphere.

**Planetary Spectra.** Spectrograms of planets are also valuable. Light from the sun enters a planet's atmosphere and is partly scattered and partly absorbed. The sunlight penetrates more or less, depending upon the particular planet's atmosphere. In any case, analysis of the light assists in finding clues to the nature of the planet's atmosphere. For instance, water vapor and free oxygen are not found in quantities large enough in Venus' atmosphere to register in the spectrum, although bands of carbon dioxide are present in surprising amounts. Jupiter's spectrum shows heavy concentrations of ammonia and methane.

**Other Spectra.** Spectra of comets are occasionally made, and these show faint solar lines as well as bright bands produced by fluorescence of the cometary gases. Such gases may be cyanogen, carbon, nitrogen hydride, and other compounds. Spectra also are made of variable stars, novae, planetary and diffuse nebulae, and far-distant galaxies. All spectra reveal facts otherwise unobtainable. *See also* Astronomical Instruments; Spectroscopy; Stars. H. S. R.

**SPECTRE DE LA ROSE, LE** [lə spɛ′ktr də la rɔ′z], a ballet by Michel Fokine, based on a poem by Gautier, set to Weber's *Invitation to the Waltz,* and first performed at Monte Carlo in 1911. A young girl returns from a ball. She falls asleep and dreams that her rosè comes to life and dances with her. She awakens and sadly embraces the wilting rose. Just as the last few bars of *Invitation to the Waltz,* although essential to the composer's purpose, are likely to seem anticlimactic, the brief passage of the young girl's awakening in the ballet appears ineffective after the applause following the exit of the Spectre. Vaslav Nijinsky and Tamara Karsavina constituted the original cast. The sensational leaps of Nijinsky upon his entrance and his exit gave the ballet a degree of fame it might otherwise never have attained. *See also* BALLET. F. G. P.

**SPECTROGRAPH.** *See* ASTRONOMICAL INSTRUMENTS (*Astrophotography*); SPECTROSCOPY.

**SPECTROHELIOGRAPH.** *See* ASTRONOMICAL INSTRUMENTS (*Astrophotography*).

**SPECTROPHOTOMETRY.** *See* ANALYTICAL CHEMISTRY (*Physical Methods*).

**SPECTROSCOPIC BINARIES** [spɛ′ktroskɒ′pɪk bai′nəriz], double stars that revolve around a common center of gravity and have components apparently so close together that they cannot be separated with the largest telescopes. The fact of their being binary systems is known from spectroscopic observations, that is, by the shift in their spectral lines due to motion. This change of position of spectral lines determines the period of revolution of the stars. Capella, $\beta$ Aurigae, Mizar, and Spica are typical spectroscopic binaries. *See also* BINARY STARS. H. S. R.

**SPECTROSCOPY** [spɛktrɒ′skopi], the observation and interpretation of the light emitted by physical objects; more especially, the interpretation of the light emitted by excited atoms (and molecules) in the gaseous state.

Lower case letters are used for the quantum numbers of an electron, *n, s, l, j, m,* and capital letters for the atom as a whole, *N, S, L, J, M.*

## EARLY HISTORY

**Origin of Science.** The science of spectroscopy had its beginning in the observation by Sir Isaac Newton in 1666 that the white light from the sun was dispersed into a colored spectrum by passage through a glass prism. In Germany in 1814, J. Fraunhofer extended Newton's discovery by observing that the sun's spectrum, when sufficiently dispersed, was crossed by a large number of fine dark lines, later known as Fraunhofer lines. Terrestrial sources, such as flames, were found to emit bright lines which were characteristic of the chemical elements in the flame. Foucault, the French physicist, observed in 1848 that a flame containing sodium would absorb the yellow light emitted by a strong arc placed behind it. These facts were brought together in 1859 by G. Kirchhoff in his famous law: that the ratio between the powers of emission and the powers of absorption for rays of the same wavelength is constant for all bodies at the same temperature. He explained that the Fraunhofer lines in the sun's spectrum were caused by action of elements in the cooler sun's atmosphere in absorbing the continuous spectrum emitted by the hot interior of the sun. Analysis of the sun's atmosphere thus became possible. The method was extended later to stellar spectra and constitutes our only means of studying the chemical elements occurring in the stars.

**Spectra Measurement.** The provision of accurate wave length measurements resulted from the work of Rowland, Michelson, Fabry, and Perot. The relative accuracy attained reached one part in ten million, and most measurements can be relied on to .01 Å, where the Angstrom unit (Å) is $10^{-8}$ cm. The visible spectrum extends between the approximate limits 4000 Å and 7500 Å, but observations by photography have been made from about 10 Å to 13000 Å. Spectra can be produced in a great variety of ways. The commonest is to use the element whose spectrum is required as the poles of an electric arc, or in carbons which form the poles. Sparks of any intensity may be employed for higher excitation. For special purposes, other sources are available, such as low pressure gas discharges, vacuum ovens, fluorescence produced by radiation, absorption, and atomic beams. Complete observation of a spectrum may involve the use of several different sources, because different parts of the spectrum may be differentially excited. It also may require a variety of instruments, in order to cover the complete range of intensities and wave lengths.

**Formula for Lines.** Regularities among the lines in the simpler spectra were found in the early work. The most

*Fig. 1—SPECTROGRAPH OF BALMER SERIES OF HYDROGEN*

obvious was the regular progression of lines, known as the Balmer Series of Hydrogen (*See* Fig. 1). Attempts to fit these lines into a system of harmonics from analogy with mechanical vibrations were unsuccessful, but, in 1885, J. J. Balmer discovered that the lines were given by a simple formula, which in recent notation is:

$$\nu = R\left(\frac{1}{4} - \frac{1}{n^2}\right).$$

In this formula, $\nu$ is the wave number, or reciprocal of the vacuum wave length, $R$ is a constant, and $n = 3, 4, 5,$ etc., for the successive lines. It was soon found that there were series of lines in other spectra which satisfied a somewhat modified formula, due to Rydberg. This, using the same constant $R$, is:

$$\nu = \nu_\infty - \frac{R}{(n + \mu)^2}.$$

In this formula, $\nu_\infty$, $R$ and $\mu$ are constants and it is obvious that $\nu_\infty$ is the limit of the series, i.e., that point in the spectrum to which the lines converge. The alkali metals, for example, produced the following series: the principal series, containing the strongest lines; the sharp and diffuse series, so called because their lines were sharp and diffuse, respectively; and the fundamental or Bergmann series in the infrared. All of these obey such formulae. In addition, the Rydberg-Schuster law was discovered, giving certain relations connecting the various series.

The most striking fact emerging from these observations was that the wave number of a spectrum line always appeared as the difference between two other numbers. This was stated in the Ritz combination principle and became fundamental in the quantum theory.

## BOHR THEORY

**Quantum Picture.** In 1913, N. Bohr initiated a new era in the interpretation of spectra when he gave the first quan-

tum picture of the hydrogen atom. Following E. Rutherford's suggestion of a planetary atom, Bohr applied the principles of the quantum theory to the system consisting of a positively charged nucleus, containing the main atomic mass, and an electron revolving around it in the inverse square force field. He made the radical assumptions that the angular momentum in an allowed orbit had to be an integer times the quantity $h/2\pi$, where $h$ is Planck's constant, and that the radiation obeyed the equation $h\tilde{\nu}=W_1-W_2$, in which $\tilde{\nu}$ is the frequency, and $W_1$ and $W_2$ are the energies of the atom in any two states. The latter relation was obviously inspired by the Ritz combination principle. When put in terms of known atomic constants, the Bohr relation gave:

$$\nu = N^2R\left(\frac{1}{n^2}-\frac{1}{m^2}\right),$$

where $n$ and $m$ are integral and $m$ is larger than $n$, and where $\nu$ is the wave number of a line, $N$ is the charge on the nucleus in electronic units, and

$$R=\frac{2\pi^2\mu e^4}{ch^3},$$

$c$ being the velocity of light and $e$ and $\mu$ the charge and mass of the electron. The agreement with observation is well within the experimental error. The spectrum of hydrogen is now known to include the series for which $n=1$ (Lyman series), $n=2$ (Balmer series), $n=3$ (Paschen series), $n=4$ (Brackett series), and $n=5$ (Pfund series).

The general picture of an atom as a positive nucleus surrounded by a cloud of electrons emerged from the Bohr theory and became fundamental in all atomic theory. This meant that the whole structure could exist in a large number of discrete energy states, and radiation took place according to Bohr's frequency condition. The condition of zero energy employed by Bohr is that in which the nucleus and one electron are infinitely separated, i.e., the atom is ionized. In terms of the series formula, this means that the limit corresponds to ionization. Beyond the series limit, a continuum exists which corresponds to the removal of the electron with a finite velocity. Such a final state is not quantized and can theoretically yield the observed continuous spectrum, which extends from the series limit toward shorter wave lengths.

## EXTENSION OF BOHR THEORY

**Heavier Atoms.** In the years immediately following Bohr's theoretical discovery, the application of its principles to the spectra of heavier atoms was taken up by A. Sommerfeld and many others. An important advance was made by considering the possibility of elliptical as well as circular orbits. Because of relativity effects, this introduced small energy differences, which could account for fine structure in the hydrogen lines, but its importance increased greatly when it was made the basis for explaining the important differences between hydrogen and other spectra.

*Sodium Series.* It was pointed out that sodium gave a number of series which obeyed the Rydberg formula:

$$\nu=\nu_\infty-\frac{R}{(n+\mu)^2}\quad .$$

These series are related in such a way that they can all be described by means of the following diagram (*See* Fig. 2), usually called a Grotrian diagram.

In the diagram, the value of $\nu_\infty$ for the principal series is plotted on the left, downward from the zero line, while the variable term values for that series are plotted in the second column. The first column is then filled by the variable terms of the sharp series and a third column is used for the variable term of the diffuse series. A fourth column includes the variable term of the fundamental series. These columns are labelled $^2S$, $^2P$, $^2D$, $^2F$, and the levels in each column are

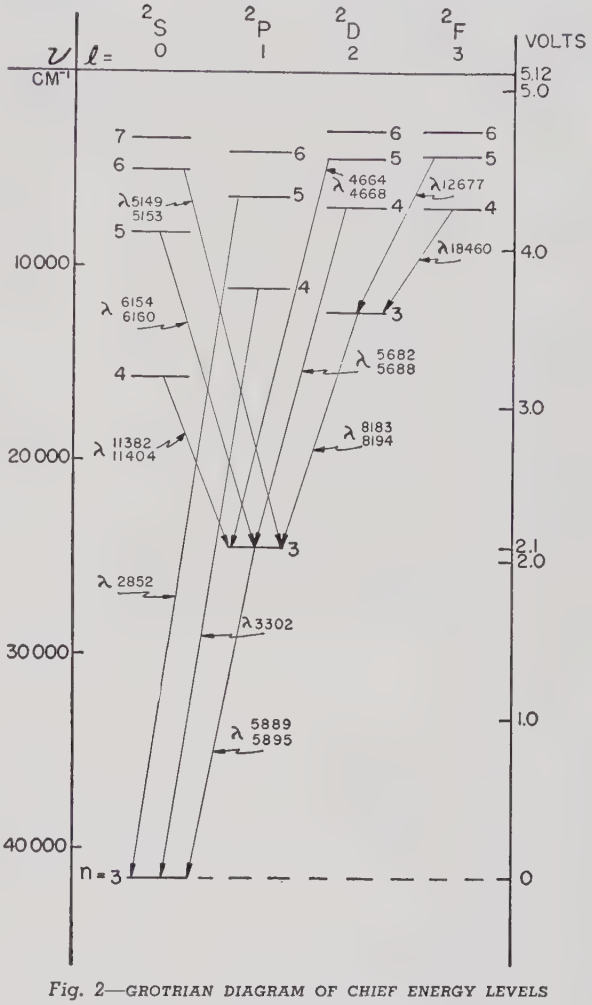


*Fig. 2—GROTRIAN DIAGRAM OF CHIEF ENERGY LEVELS OF SODIUM*

given a running number. Obviously, from the construction of the diagram, the wave number of a spectrum line is given by the vertical difference between the corresponding levels in the diagram and the various series can be written formally as follows:

| | |
|---|---|
| Principal series | $3^2S-n^2P$ |
| Sharp series | $3^2P-n^2S$ |
| Diffuse series | $3^2P-n^2D$ |
| Fundamental series | $3^2D-n^2F$ |

The significance of the superscript 2 is explained later; $n$ is called the principal quantum number of the level of higher energy.

It might appear from the Ritz principle that an observed frequency should be obtained by taking the vertical difference between any two levels. All such differences, however, do not correspond to radiation. It is found empirically that only transitions between levels in neighboring columns give lines of appreciable intensity. In agreement with theory, this restriction is formally introduced by assigning to each column a number $l=0$, 1, 2, etc., for $S$, $P$, $D$, etc., and the rule is then $\Delta l=\pm 1$ for radiation.

*Doublet Spectra.* An additional refinement of the greatest importance was found early in spectra such as sodium. Each line was found to be at least double, the lines of the principle series closing together in successive terms, and the diffuse and sharp series having constant differences. This fact necessitated the doubling of certain of the terms. The spectra showed that the $S$ terms were always single, the $P$ terms double and decreasing in separation up the series, the $D$ terms double but much narrower. Still another selection law was found to be necessary, since all possible transitions between doublet levels did not occur. This required the introduction of another quantum number called $J$ and having the values: for $S$ terms ½; for $P$ terms ½ and 1½; for $D$ terms 1½ and 2½; and so on. The rule which gives all observed transitions is $\Delta j = 0$ or $\pm 1$. Accordingly, a $^2P - {}^2D$ group includes only three lines since $^2P_{1/2} - {}^2D_{2}{}^{1/2}$ is not an allowed transition under this rule.

*Alkali Metals.* Many atoms emit spectra of the same character as sodium, notably all of the alkali metals. The metals *B, Al,* etc., have doublet spectra lacking the lowest $^2S$ term, and both they and copper, silver, and gold have additional complications. Doublet separations increase rapidly with increasing atomic weight, so that the name "fine structure," usually applied to this feature of spectra, is somewhat of a misnomer. For instance, in lithium $\Delta\nu(^2P) = .34\text{cm.}^{-1}$ and in cesium $\Delta\, \nu = 554.0$. It was also found quite early that numerous spectra exist which have two separate systems of series: one of single levels, and one of triple levels. They are emitted by atoms which follow the doublet-emitting atoms in the periodic table.

*Penetrating Orbits.* The general explanation of these facts is as follows. An electron orbit of high eccentricity approaches the nucleus closely. Such an orbit in an atom of many electrons penetrates into the inner electronic structure and comes under the influence of the higher field existing there. It is, therefore, more tightly bound than a nonpenetrating electron and is lower in the energy scale. The letter $l$, introduced above, corresponds in the quantum mechanics to the angular momentum. Theoretically $S$ terms are due to penetrating orbits and lie lower than $P$ or $D$ orbits of the same total quantum number. $F$ terms correspond to nearly circular orbits and have energies very close to the hydrogen values, as would be expected. The quantum mechanics gives the rule for a transition $\Delta\, l = \pm 1$ in agreement with observation.

*Electron Spin.* The doublet character of the terms, which was at first thought to be due to a characteristic of the nucleus, led Goudsmit and Uhlenbeck in 1925 to the introduction of the idea that the electron must possess an intrinsic spin of angular momentum $\frac{1}{2}\frac{h}{2\pi}$ and a magnetic moment $2\frac{e}{2mc}\frac{1}{2}\frac{h}{2\pi}$. In the quantum theory, the total angular momentum of the electron, and, in the cases under consideration, the whole atom, can accordingly have only the two values $j = l + ½$ and $j = l - ½$, which differ in energy by a calculable amount.

## ZEEMAN EFFECT

**Split Lines.** In 1896, P. Zeeman discovered that, when a source of spectrum lines is placed in a strong magnetic field, the lines are split up into a number of close components whose displacements from the original position of the line are proportional to the field. This is what would be expected classically of a Bohr atom in a magnetic field. The magnitude of the observed splittings and the number of components do not, however, agree with the classical result. When a charge is moving in an orbit of angular momentum $P$, the magnetic moment associated with its motion is $\frac{e}{2\mu c} \times \text{P}$. To account for the anomalous Zeeman effect, the angular momentum of an electron is taken as $\frac{1}{2}\frac{h}{2\pi}$ and the magnetic moment as:

$$\mathbf{2}\,\frac{e}{2\mu c}\,\frac{1}{2}\,\frac{h}{2\pi},$$

or twice as great as might be expected. When an atom is introduced into a magnetic field, a precession around the field direction results, and the component of the magnetic moment in the field direction retains a constant value $M$ which, in the quantum theory, can only be one of the following integral values: $M = J$, $(J - 1)$, and so on to—$(J)$. The energy of each of these precessional motions differs from that of its neighbors by a constant amount, so that the effect of the field is to split a level $T_0$ into several equally spaced levels given by $T = T_0 - M\, g\, L$, in which $L$ is the classical splitting predicted by Lorentz and $g$ is the factor by which the atom departs from the classical case because of the anomalous electron moment. The value of $g$ is:

$$g = 1 + \frac{J(J+1) + S(S+1) - L(L+1)}{2J(J+1)}$$

**Combined Levels.** When two levels combine to give radiation in the presence of a magnetic field, transitions occur only for $\Delta\, M = 0, \pm 1$, the zero changes giving light polarized with the electric vector in the direction of the field, and the $\pm$ changes, perpendicular to the field. Since the $g$-values vary for different states of the atom, the Zeeman effect affords a powerful means of telling the nature of the two levels which give rise to an observed line. A measurement of all the components gives not only the two $J$-values involved, but also the two $g$-values associated with them, and, consequently, the term types. A further effect occurs (Paschen-Back effect) if the field is increased to such an extent that $M\, g\, L$ becomes larger than the fine structure, due to the interaction between the electron spin and the electron orbit. The Zeeman pattern becomes unsymmetrical, and, eventually, goes over into a simple classical pattern about the center of gravity of the fine structure. In this condition, the $J$-value of the atom no longer exists because the powerful magnetic field has effectively broken down the coupling between $L$ and $S$. The atom still has an $M$ value, but this is the sum of $M_L$ and $M_S$. These two new quantum numbers are the components of the spin and orbital momenta in the direction of the magnetic field.

## COMPLEX SPECTRA

**Singlets and Triplets.** It has been mentioned above that, from an early date, spectra were known which required the assumption of a set of single levels and a set of triple levels. Numbers had to be assigned to all of these levels to account for the emitted lines. Those numbers, now known as $J$-values, are, 0, 1, 2, etc., for $^1S$, $^1P$, $^1D$, etc., for $^3S$, $J = 1$; for $^3P$, $J = 0$, 1, 2; for $^3D$, $J = 1$, 2, 3, etc. The rule for a radiative transition is $\Delta J = 0, \pm 1$, with the exception that $J = 0$ to $J = J = 0$ does not occur. In the spectra of light atoms, there are few and faint lines due to transitions from one system to the other, but, from heavy atoms, such intersystem lines may be very strong. For example, $\lambda$ 2536, one of the strongest lines in the mercury spectrum is $^1S_0 - {}^3P_1$.

Generally, though not always, it is true that the triplet levels are lower than the corresponding singlet levels, and that the lowest level of all is a $^1S$, for which there is no triplet counterpart. The Zeeman effect of singlets and triplets is deducible from the same formula, which applies to doublets if we take $S = 0$ for singlets and $S = 1$ for triplets.

**Multiplets.** In 1922, Catalan made the important discovery that there were groups of lines in the spectrum of manganese that were more complicated than triplets. He showed that such "multiplets" could be formally explained by assuming that the combining terms had more than three components. It became necessary, therefore, to extend the possible term systems to include quartets, quintets, etc. The key to the existence of multiplicities, other than the doublets of one electron spectra, was found by Russell and Saunders in 1925. From very complete analyses of the spectra of the alkaline earths, Russell and Saunders were led directly to the necessity of believing that the atom radiates as a whole, and that more than one electron may change its state during a transition. The state of the atom is then the resultant of the states of several electrons, presumably two in the case of calcium. Accordingly, they assumed that the resultant $L$ of the atom was the vector sum of the $l$'s of the electrons, and that, likewise, the resultant $S$ was the sum of the electron spins. For two electrons this leads at once to $S = \frac{1}{2} + \frac{1}{2} = 1$ or $\frac{1}{2} - \frac{1}{2} = 0$, giving the proper values for triplets and singlets. The type of term is determined by the quantum number $L$, which can have any positive value from $|l_1 = l_2|$ to $|l_1 - l_2|$. For instance, if we use $s$, $p$, $d$ to denote electrons with $l = 0$, 1, 2, respectively, the structure $sd$ gives $^3D$ and $^1D$ terms. Likewise, the structure $pd$ gives $^3P$, $^3D$, $^3F$, $^1P$, $^1D$ and $^1F$, and an electron transition from $p$ to $s$ is the origin of several multiplets instead of one, as in a doublet spectrum. These three multiplets in calcium are shown in Fig. 3.

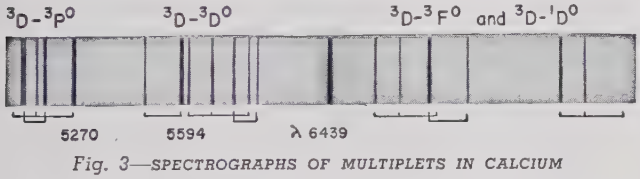


*Fig. 3—SPECTROGRAPHS OF MULTIPLETS IN CALCIUM*

*Change in Rule.* The former selection rule must be altered to take account of the new facts. Its most general form is that the arithmetical sum of the $l$'s must change from odd to even, or vice versa, in a radiative transition. Usually, however, the stricter rule holds, meaning that one $l$ changes by unity and the others remain fixed. The $J$ values of the various terms are given by the vector sums of $S$ and $L$, so that the number of levels in a term is $2S + 1$ or $2L + 1$, whichever is the smaller. Accordingly, $S$-terms are always single, $P$-terms never more than triple, and $D$-terms never more than quintuple, no matter how great the multiplicity.

The Russell-Saunders coupling scheme allows an explanation of the observed occurrence of even multiplicities with an odd number of electrons, and vice versa. Because the electron spin is half integral, the resultant spin for an odd number of electrons is also half integral, and the multiplicity $2S + 1$ must be an even integer. If the number of electrons is even, $2S + 1$ is an odd integer. Three electrons can then give rise to quartets and doublets, four electrons to quintets, triplets, and singlets, and so on. Such multiplicities are observed in the spectra of the first long period, of elements in the periodic table rising to octets, sextets, quartets, and doublets in manganese.

To describe an energy level of an atom, procedure requires that its $S$, $L$ and $J$ values be stated. It is customary to use a capital letter for the $L$ value, with a left superscript giving the multiplicity $2S + 1$, and a right subscript giving the $J$-value. The letters adopted for levels of successively higher $L$ starting from $L = 0$ are $S$, $P$, $D$, $F$, $G$, $H$, $I$, $K$, $L$, $M$, $N$, $O$, $Q$. For example, if a level has $S = 2$, $L = 4$ and $J = 3$, it is written $^5G_3$.

**Atomic Model.** Certain general features of spectra are explainable qualitatively, and, to a certain extent, quantitatively, by the Bohr theory and the more correct wave mechanics. There are various energy differences which can be visualized as follows. The electron, with its spin and magnetic moment, moves in an orbit around the charged nucleus in both an electric and magnetic field. The potential energy of the electron in the magnetic field depends upon the orientation of the electron spin; therefore the levels $J = l + \frac{1}{2}$ and $- \frac{1}{2}$ have different energies, the lower being $j = l - \frac{1}{2}$ in agreement with observation. In the more complicated case, where the atom has a spin vector $S$, this same magnetic interaction produces a splitting into a number of levels. There is an energy term which is proportional to the cosine of the angle between $L$ and $S$, and this leads, in quantum mechanics, to the Lande interval rule. This rule, found to be approximately true in practice, is that the energy intervals between the levels of different $J$ are in proportion to the greater of the two $J$'s surrounding them. For instance, a $^3P$ term with $J$'s 2, 1, 0 should have intervals in the ratio of 2:1.

**Energy Difference.** Another separation which was important in the theoretical development is that between singlets and triplets. In a spectrum like calcium, $^3P$ is usually found below $^1P$ of the same principal quantum number $n$. This was based on a crude atomic model and was viewed as due to the forces between the two electron spins, the energy difference being a measure of the work necessary to reverse one spin with respect to the other. However, this naïve explantation was insufficient, and Heisenberg showed that the energy difference is due to exchange forces, which enter in quantum mechanics because of the identity of the two electrons. Another energy difference is that introduced by the different angles between $l_1$ and $l_2$ when they are coupled together to give different resultant $L$'s. Simple theory predicts that such terms should have energies in the order of their $L$ values, with largest $L$ lowest, but this is by no means the case in observed spectra.

**Intensities of Lines.** The relative intensity of spectrum lines covers a very wide range. It depends on the types of terms involved and on the $J$-values. Detailed formulae have been deduced for certain types of transition, especially for Russell-Saunders coupling. Agreement with observation is only approximate but is usually sufficiently close to assist in the identification of most terms of a spectrum. In general, strong lines arise from changes of $J$ in the same direction as $L$ and the strongest involve the largest $J$'s.

## SPARK SPECTRA

**Analysis and Rules.** As remarked above, the arc spectra of elements of even atomic number have odd multiplicities and vice versa. If, however, the means of excitation of the spectrum is more vigorous, for example a condensed spark, a new spectrum appears for any particular element consisting of terms of the opposite parity. The first spark spectrum of calcium is a doublet spectrum similar in every way to the

ordinary spectrum of potassium, except that in the series formulae $4R$ must be used in place of $R$. Such a spectrum is interpreted as being due to the calcium atom, from which one electron has been removed, leaving it with a single outer electron like potassium. Obviously, this idea can be extended to the spectra of atoms with more and more electrons removed. The spectra so obtained alternate between odd and even multiplicities and resemble the arc spectra of atoms of lower and lower atomic number. Such isoelectronic spectra are usually designated as *K*I, *Ca*II, *Sc*III, etc. As a special case, all of the spectra *H*I, *He*II, *Li*III, etc., are hydrogen-like, and their term values can be calculated accurately from the wave mechanics. The term values increase as the square of the nuclear charge, or atomic number, and the spectra, therefore, recede toward shorter and shorter wavelengths, where they form a useful set of standard wavelengths in the far ultraviolet. Simple rules exist in more complicated cases, allowing a step by step analysis to very high ionizations. The highest ionization recorded in the literature in 1947 was *Cu* XIX.

## PAULI EXCLUSION PRINCIPLE

**Periodic System.** The spectra of the elements should be expected, as they do, to reveal the reasons for the periodic character of the system of elements. At the beginning of each short period in the Periodic Table, there is an element with an ordinary doublet spectrum whose lowest term is a $^2S$. This is followed in each case by an element having a triplet-singlet spectrum with $^1S$ lowest. The following element has a $^2P$ as its lowest term, and is succeeded by an element with $^3P$ lowest. From this and much other evidence, Bohr in 1922 was able to give a logical picture of the building of the periodic system. It appeared necessary to assume that only two electrons with $n=1$ are built in, followed by two with $n=2$ and $l=0$, to give beryllium $1s^2\ 2s^2$ (using an obvious extension of the notation used above). In the following six elements, electrons with $n=2$ and $l=1$ are built in to give $1s^2 2s^2 2p^6$ for neon. The repetition of this process for $n=3$ leads to $1s^2 2s^2 2p^6 3s^2 3p^6$ at argon. Obviously, there is some fundamental law of nature preventing an atom from acquiring more than two *s*-electrons, or more than six *p*-electrons, of the same principal quantum number $n$. An examination of the remainder of the periodic system extends this law to the limitation of *d*-electrons to ten and *f*-electrons to 14. That law, whatever its origin, creates the periodic system.

**Single Rule Stated.** In 1925, W. Pauli stated a principle bringing the periodic properties of the atomic system under a single rule. This provides that no two electrons in an atom may possess exactly the same quantum numbers. The law yields the result that the number of electrons of the same $n$ and $l$ may not exceed $2(2l+1)$, in agreement with the known facts. The short periods are produced by the building in of *p*-electrons and the long periods by the *d*-electrons. The rare-earth group appears when the *f*-electrons are built in. The application of the Pauli principle also reduces the number of terms to which any electron configuration can give rise. In particular, a complete group of electrons always gives a $^1S_0$ term, which has both spin and angular momentum zero. Moreover, the removal of any number of electrons from a closed group gives the same resultant as the presence of that same number. Consequently, there is a symmetry of the periods about the center, at which an *S* term always appears: a $^4S$ in the short periods, a $^6S$ in the long periods, and an $^8S$ in the rare-earth period. The terms produced by electron groups which are more than half filled are inverted, i.e., the level of greatest $J$ is lowest in energy.

## SPECTRUM ANALYSIS

**Division of Terms.** In doublet spectra, one can divide the terms into two groups which do not combine within themselves to give radiation. These are $^2S$, $^2D$, $^2G$, etc., and $^2P$, $^2F$, and $^2H$, etc., having even and odd $l$, respectively. They are called even and odd terms to correspond with the parity of $l$, and the empirical rule is then expressed by $\Delta l=\pm 1$ for radiation. The division into two groups of terms still occurs in more complicated cases, but the parity is now determined by the arithmetical sum of the $l$'s. This leads to the following method of presenting the material of a spectrum analysis. All of the even terms are written in a horizontal row, all of the odd terms in a vertical column. The wave number of each line is then placed below its proper even level and opposite its odd level. When every observable line is fitted into such a square array, the numerical classification is complete and the energy to excite any line is known. The first step in an analysis is to find a significant difference between lines which is repeated a number of times. The procedure then is to build the square array by searching for the differences which occur in either direction. It is a numerical crossword puzzle.

**Knowledge of Levels.** To complete the analysis, it is necessary to know the type of every one of the levels, and, particularly, to know the electron structure giving rise to it. This may be accomplished by resorting to Zeeman effects, which give very definite information, and to intensities which are less certain criteria. General knowledge of other spectra assists in giving information regarding the approximate position where various structures should be found. With all of this information, it has been possible to make very complete classifications of many complex spectra. For example, by putting together the results of many workers, H. N. Russell and C. E. Moore have identified the following electron structures in iron: $3d^6 4s^2$, $3d^7 4s$, $3d^8$, $3d^6 4s 5s$, $3d^7 5s$, $3d^6 4s 4d$, $3d^7 4d$, $3d^6 4s 4p$, $3d^7 4p$, $3d^5 4s^2 4p$. They are based on an analysis which included 4860 lines, classified as combinations between 181 even levels and 283 odd levels.

**Coupling Schemes.** The analysis of spectra and our ideas concerning the atom owe a great deal to the rules given by Russell and Saunders, which led to what is called Russell-Saunders coupling. It is possible to describe a great many but not all spectra in terms of these rules. The extreme exceptions are spectra resulting from atoms in which the coupling of the electrons is known as *j-j* coupling. In such a scheme the $l$ and $s$ of each electron combine to form a $j$ for that electron; the various $j$'s then combine to form $J$ for the whole atom. An $S$ or an $L$ for the atom no longer exists and names based on such quantities cannot be used. There are intermediate cases ranging all the way between the two extremes, but spectroscopists are likely to use the Russell-Saunders notation whenever possible. The spectra of heavy atoms with many electrons are sometimes so far from any standard coupling scheme that nothing beyond a numerical analysis is possible.

**Use of Series.** Series, of course, are an outstanding feature of most simple spectra. They occur in all spectra, but frequently are very difficult to find and very short. In complicated spectra, series exist which converge to different limits. This is because the removal of an electron from an atom may leave the atom in one of a great number of states. The series leading to the lowest limit are usually the most obvious and can be used to find a zero, from which to measure the levels. However, the uncertainty of such series has

resulted in a general agreement among spectroscopists that levels should be given values measured upwards from the lowest as zero. There is no ambiguity in such a scheme, and the value of a level gives at once the energy necessary for its excitation.

### HYPERFINE STRUCTURE

**Importance of Analysis.** As long ago as 1891, Michelson observed that some spectral lines actually were very close groups of lines, with the whole structure covering only a few wave numbers. Measurement and elucidation of such hyperfine structures became very important when it was realized that they could be explained by ascribing a spin and associated magnetic moment to the nucleus. This angular momentum ($I$) must be added to $J$ to obtain the possible resultants ($F$) for the whole atom, in the same way in which $L$ and $S$ were added to give $J$. Accordingly, $F$ takes all positive values from $|J+I|$ to $|J-I|$, and the level is split into a number of hyperfine structure levels obeying the Landé interval rule. The combination of two levels results in a hyperfine-structure multiplet instead of a single line; and, indeed, since several isotopes may be present with different structures, the result may be several superimposed hyperfine-structure multiplets of differing complexities. Analysis of such structures determines the $I$ of each isotope in many cases with certainty, but the measurement of the magnetic moment is much less exact because it depends on the calculation of the magnetic field produced at the nucleus by the electrons. In some cases there are small deviations from the Landé interval rule which can be ascribed to the presence of a nuclear quadrupole moment.

### MOLECULAR SPECTRA

**Vibration and Rotation.** Because a molecule is a more complex structure than an atom, it is logical to find that its spectrum is more complicated The possible states of vibration and rotation must be added to all the possible electron structures. The result is known as a band spectrum because the lines usually appear in closely packed groups, shading off toward long or short wavelengths. A line, of course, is given by the usual relation:

$$h\nu = W_1 - W_2,$$

but $W_1$ and $W_2$ are made up of electronic, vibrational and rotational energies in descending orders of magnitude. Normally, each electron transition has many vibration transitions giving different bands, and many rotation transitions giving the smaller differences appearing within the bands. For some molecules a pure rotation spectrum is observed in the far infra-red and a rotation vibration spectrum in the nearer infra-red. In any case, a detailed analysis of the band spectrum should be capable of determining the structure of the molecule, and of its modes of ionization. *See also* ATOMIC AND NUCLEUR MOMENTS; ATOMIC STRUCTURE; QUANTUM MECHANICS; SPECTRA, STELLAR AND SOLAR. A. G. S.

**SPEEDBALL,** an outdoor game which is a combination of soccer football and basketball, with scoring methods similar to those for American football. It was invented in 1921 by Elmer D. Mitchell, of the University of Michigan. The field and goals are the same as for American football, and the official ball resembles a soccer football but is slightly larger. Teams are of eleven men each.

The characteristic feature of the game is that a ground ball may not be touched with the hands but must be kicked or given impetus by the body, as in soccer football, whereas a fly ball must not be kicked but may be caught and then thrown, punted, or drop-kicked. A fly ball is one that has not touched the ground at any time since it was last played. A ground ball that is kicked into the air may be caught by any player, including the kicker himself. Thus the game is played much like basketball until the ball touches the ground and is then played like soccer football until some player catches a fly ball. However, the basketball dribble is prohibited, and there is no goal keeper with special privileges.

Points may be scored in five ways: A field goal counts 3; it is the same as a soccer football goal and is made by kicking a ground ball under the cross-bar. A touchdown, made by catching a forward pass in the end-zone, counts 2. Each of the following counts 1 point: an end kick, made by kicking the ball across the end line from within the end-zone; a drop-kick, made by drop-kicking the ball over the cross-bar from a point outside the end-zone; and a penalty kick, made from a free-kick following a foul. D. A. H.

**SPEEDWELL,** a large genus, *Veronica,* of the figwort family, comprising about 150 species of herbs and subshrubs native to temperate and colder regions. Many are grown as garden ornamentals, and some are used medicinally. They are mostly low plants, having blue, pink, or white flowers; usually the stem leaves are opposite, and the floral leaves alternate. Some 20 species occur in North America; of these, about half were introduced from Europe. Among the best known are the drug speedwell, *V. officinalis;* the purslane speedwell, *V. peregrina;* the thyme-leaved speedwell, *V. serpyllifolia;* the common speedwell, *V. arvensis;* the field speedwell, *V. agrestis;* and the ivy-leaved speedwell, *V. hederaefolia.* The name speedwell is derived from the transitory nature of the flowers, which drop at the slightest touch. *See also* VERONICA. R. P. T.

**SPELLING** may be defined as the usual method of writing words by means of letters, as distinguished from code writing and phonetic transcriptions. Since letters are in origin phonetic symbols, it follows that at some time every spelling must have been more or less phonetic, the reservation *more or less* deriving from the fact that generally the letters are inferior in number to the phonemes they have to represent, with the result that one letter may frequently have more than one phonetic value. Since languages change constantly, however, it inevitably happens that, unless the spelling is reformed from time to time, it will diverge more and more from the pronunciation, up to a point where it becomes almost ideographic; the pronunciation of the modern English words *Leicester, Worcester, cough, though, knight, know,* and *naughty* has now so little relation to the spelling that these words have to be learned one by one, not on the basis of any general rule of pronunciation. While this happens to a greater or smaller extent in many languages, there is no doubt that a few languages, such as Serbian, Lithuanian and Basque, have a spelling that corresponds almost perfectly with pronunciation; but others, like French, have a spelling that is widely divergent. Antoine Meillet observed that the spelling of Spanish was excellent (perhaps an overstatement), and the spelling of Italian good; if his standard were applied to other languages, German and Russian spellings would be considered mediocre, French worse, and English worst of all (with the possible exception of Irish and Tibetan).

The main reason for the peculiarity of English spelling lies in the very formation of the English language, for it has kept or reintroduced the old historical spelling of the four principal languages of which it is formed: Old English, Old French, Latin, and Greek. In words of Old English

origin, the sound *i* became *ai* in open syllables (*bide, hide, wife, shine*); but this did not happen in *machine,* a word of late French origin. Likewise, no rule whatever can be given for the pronunciation of *g* in front of the vowels *e* and *i,* for *g* has preserved a velar articulation in words of either Old English origin (*geese, giddy, gild, begin*) or Norse origin (*get, gift*); whereas in words of French, Latin, and Italian origin it has mostly the Old Romance (Old French and Italian) value of *dž* (*general, gigantic*). In Greek words, English, like French and German, has preserved the standard Latin transcription and pronunciation, not the Greek: this produces such spellings as *physiology, photography, chemistry, character, chorus.* This transcription once introduced, even new words formed with Greek elements, such as *telegraph* and *telephone,* are spelled in the same way.

In general, apart from Greek words, English spelling reflects the pronunciation of English as it was several centuries ago. Thus the Old French words, for the most part, preserve the pronunciation they had at the time of the Norman Conquest, except for their accent, which, under the influence of Old English, was usually shifted to the root syllable. On this point English *feast, haste, saint, point, danger, cloister, chamber, general* may be compared with Modern French *fête, hâte, saint, point, danger, cloître, chambre, général.* Since French also has preserved the spelling of that period as a general rule, it so happens that many words are spelled the same way in French and in English (*danger, point, saint*) but pronounced quite differently, the English pronunciation being much more archaic, and therefore more phonetic (nearer to the spelling).

Both in French and in English, the learned influence has introduced letters into the spelling of certain words in order to bring them closer to the true or supposed Latin original. Sometimes English has gone further than French in this trend, spelling *doubt* with a silent *b,* for example, out of regard for Latin *dubitare,* while French preserves the form *doute.* More frequently, however, French has gone further than English, spelling *temps* (from Lat. *tempus*) with a silent *p,* for example, while English preserves the form *tense.* French *poids* and English *poise* both derive from Latin *pensum,* a fancied connection with Latin *pondus* being responsible for the silent *d* in the French spelling.

The relationship between the spoken and the written word is so close, and in Western culture the importance of the book and the journal is so great, that sooner or later, in many words, letters that should not be pronounced come back to life again. In the word *often,* for example, the *t* is heard more and more frequently (though not in *soften, hasten, listen,* and *fasten*); in *fault, altar, vault,* and *falcon* the *l* was formerly not pronounced. The most important and comprehensive examples of this phenomenon of revival are furnished, however, by French, Latin, and Greek words containing the letters *th* and initial *h.* When Greek words were transcribed in Latin characters, the symbol *th* was used for the sound represented by the letter *θ,* and the symbol *h* was used for the sound represented by the so-called "rough breathing." In the Middle Ages the initial *h* was not pronounced and *th* was pronounced *t*; in the development of the English language, however, analogy with words from Old English in which these symbols had the value of *h* and of *θ* (e.g., *house, high, he; thin, thick, death*) brought about a similar pronunciation when the symbols were found in Greek and Latin words, and usually when they were found in French words. As a result, English has such pronunciations as *hemisphere, hemophile, hospital, host, human, herbarium, theology, theatre,* and *mathematics.* Only a few French words kept the silent *h*: e.g., *heir, honest, honor, hour;* others oscillate: e.g., *herb, humor, homage, humble.* Another example of revived pronunciation may be found in the English word *corpse,* derived through Old French from Latin *corpus.* In this case the letter *p* was introduced through learned influence and then pronounced; the Old French word was *cors.* Modern French *corps* also contains an inserted *p,* but it is not pronounced; and the *p* in Modern English *corps,* which came from the French much later than *corpse,* is likewise unpronounced.

It also happens that letters introduced erroneously under learned influence came to be pronounced, thus altering the nature of the words in which they appear, and producing etymological monstrosities. Thus Latin *letalis* ("deadly"), from Latin *letum* ("death"), was somehow picturesquely connected—by what is usually called popular or false etymology—with Greek *Lethe,* the river of oblivion; the result was *lethal,* with a pronounced *th.* In like manner, the *h* in *author* and *anthem* was introduced by mistake, and the *th* in those words is now pronounced as a fricative. The old pronunciation is still preserved, despite the spelling, in *Thomas, Thames,* and *Anthony,* though the pronunciation of the last two wavers. *Delight* was once spelled *delite,* and then connected with *light; rhyme* was once regularly written *rime.*

The eccentricity of English spelling is clearly demonstrated by two sets of facts. First, the same symbol (letter or group of letters) often represents two or more sounds (e.g., *cough, tough, enough, though, through, plough, hiccough;* also *ghost, night; create, heat, great, threat; convey, key; hate, hat, father; few, sew; low, how*). Secondly, the same sound is expressed by two or more different symbols (e.g., *Thomas, tide, ptomaine, phthisic; who, two, flew, flue, food, rule, route, rheum; machine, believe, receive, weed, heat, complete; let, Thames; ashes, caution;* as an advertising slogan puts it, *eye it, try it, buy it*). It even happens frequently that two different words, with different sounds and meanings, are written in the same way: for example, *bow* (verb and substantive), *contrast* (verb and substantive), *contract, present,* and *refuse.* It is possible for *w* and *y* to have the value either of vowels (as in *symbol, new*) or of consonants (as in *yes, water*).

Many believe that the complicated system of English spelling has few, if any, advantages, and many great disadvantages. The idea of reforming it has made little headway, however, even though reform measures have been fervently and repeatedly advocated by distinguished men, George Bernard Shaw among them. Such slight changes as *thru* for *through, boro* for *borough,* and *altho* for *although* have found little favor; the American spellings *labor, color,* and *endeavor* have not penetrated into England, despite the recommendation of H. W. Fowler in *A Dictionary of Modern English Usage.* Many systems of phonetic or simplified spelling have been advocated, of varying degrees of merit; none has found much acceptance. G. B.

**SPELLMAN, FRANCIS JOSEPH** [spɛ'lmən] (1889- ), American cardinal and archbishop, was born in Whitman, Mass., May 4, 1889. He was educated at Fordham University and the University of the Propaganda in Rome, graduating with the S.T.D. degree in 1916. He then became an assistant to All Saints' Parish, Roxbury, Mass., and in 1918 joined the editorial staff of the *Boston Pilot.* In 1922 he was appointed assistant chancellor of the Boston archdiocese, and in 1925 was made attaché to the Papal Secretariat of State. Named auxiliary bishop of Boston in

1932, he was promoted to the archbishopric of New York in 1939, and in the same year was appointed military vicar of the armed forces of the United States. He was created cardinal in 1946. During the Korean war he made Christmas visits to the battlefront during each of the years 1951, 1952, and 1953. Cardinal Spellman's publications include *The Word of God* (1922) and *In the Footsteps of the Master* (1924), both translations; *The Road to Victory* (1942); *Action This Day* (1943); *The Risen Soldier* (1944); *No Greater Love* (1945); and a best-selling novel, *The Foundling* (1951). W. C.

FRANCIS JOSEPH CARDINAL SPELLMAN

BROWN BROTHERS

**SPELMAN COLLEGE** [spɛ′lmən], an accredited, privately controlled college of arts and sciences for Negro women. It is affiliated with the Baptist Church, and is situated on a campus of 23 acres in Atlanta, Ga. A member of the Atlanta University system, the college is operated with Morris Brown College, Clark College, Morehouse College, and Gammon Theological Seminary. The college was founded by the Woman's American Baptist Home Mission Society. First instruction was offered under the name of the Atlanta Baptist Female Seminary in 1881. The charter was granted in 1888. The name was changed to Spelman Seminary in 1884, in honor of Mrs. Lucy Henry Spelman, and to Spelman College in 1924. The Spelman College Nursery School was established in 1930.

Only the A.B. and the B.S. degrees are offered. There is some scholarship aid. Opportunities for self-help enable some of the students to earn part of their expenses. Dormitories and dining halls are provided. Out-of-city students live on the campus unless permission is granted to live elsewhere. *For statistics see* COLLEGES AND UNIVERSITIES. J. R. To.

**SPELT,** *Triticum spelta,* a variety of wheat with slender, loose, bearded ears and small triangular grains. In former times spelt was common and was especially grown in poor soils. Today its cultivation is comparatively unimportant. The grain which in the United States is generally called spelt is really emmer. The grains are held tightly in the chaff and are not hulled in threshing. *See also* WHEAT. C. K. H.

**SPEMANN, HANS** [shpe′mɑn] (1869-1941), German physician, biologist, and zoologist, was born in Stuttgart, June 27, 1869. For a time he worked in his father's publishing business, then became interested in medicine and entered the University of Heidelberg, where he studied comparative anatomy and took a degree in medicine. Spemann studied zoology, botany, and physics at the Zoological Institute in Würzburg from 1894 to 1904, and his instructors there, Boveri, Sachs, and Roentgen, all exercised a profound influence upon his career. He was appointed professor of zoology at Rostock University in 1908 and became director of the Kaiser Wilhelm Institut at Berlin-Dahlem in 1914. Five years later he was appointed professor of zoology at the University of Freiburg and held the post until his death. The greater part of Spemann's researches were in the fields of experimental biology and experimental zoology, particularly among amphibia. In embryology he succeeded in accomplishing complete development of frogs' eggs by mechanical and chemical stimulation and without fecundation. Spemann received the 1935 Nobel Prize for physiology and medicine for his discovery of the organizer effect in embryonic development. He demonstrated that certain parts of tissue of the embryo contain comparatively simple chemical substances that organize and direct the development of an embryo. Spemann died at Freiburg on Sept. 12, 1941. D. D. M.

**SPENCE, THOMAS** (1750-1814), British bookseller and economic reformist, was born in Newcastle-on-Tyne, June 21, 1750. After his education in local schools he became a clerk, later teaching for several years. Early in his career Spence became deeply interested in the question of land tenure and devoted the rest of his life largely to campaigning for reforms in the proprietary system. In 1775 he wrote a pamphlet, *The Real Rights of Man,* proposing the abolition of landlordism and urging land tenure on a semisocialistic basis; money from rents would be divided among the parishioners, but no taxes would be levied. Other features of his communal system were compulsory military training and a sabbath every five days. In later pamphlets Spence elaborated on these proposals and outlined a Utopian state named "Spensonea." In 1801 Spence was imprisoned for a year and fined for seditious libel. He attracted many disciples known as Spenceans who, after his death in London, Sept. 8, 1814, continued to advocate his views. G. Q.

**SPENCER,** the name of a prominent English family, whose several branches were honored with the earldoms of Sunderland and Spencer and the dukedom of Marlborough. The family traces its descent from Robert Despencer, steward to William the Conqueror, and, through the brothers Hugh le Despenser, the favorites of Edward II, to Sir John Spencer (d. 1522), who acquired the estates of Wormleighton and Althorp. Sir John Spencer's great-great-grandson, Robert Spencer, first Baron Spencer of Wormleighton (d. 1627), was reputed to be the wealthiest man in England.

**Earls of Sunderland.** Robert Spencer's grandson, Henry Spencer (1620-1643), was created first Earl of Sunderland some three months before his death at the first Battle of Newbury (1643). His only son, Robert Spencer (1640-1702), by his wife Dorothy, who was the well-known "Sacharissa" of Edmund Waller and the daughter of Robert Sidney, Earl of Leicester, succeeded him in the earldom and, after serving on embassies to Madrid, Paris, and Cologne in 1671-1678, was appointed secretary of state for the northern department in 1679, becoming a member of the powerful inner cabinet. Two years later he was dismissed from the Privy Council in consequence of having adopted the side of the exclusionists, but the following year he was reconciled to the king. So successful was Sunderland in cultivating the influence of the Duchess of Portsmouth and the French ambassador, Barillon, that he was reappointed to his secretaryship in 1683 and grew increasingly successful in his rivalry with Rochester

and Halifax. On the accession of James II in 1685 he was given the post of lord president, in addition to that of principal secretary of state, and succeeded in remaining in the king's favor despite the denunciations of Monmouth and Rochester. In 1688, having joined the Catholic party, he renounced Protestantism but continued to correspond with the Prince of Orange, whom he had cultivated through his uncle Henry Sidney. In the crisis of 1688 he came under suspicion for failing to suggest adequate remedial measures, was dismissed, and fled to Rotterdam, but he returned to England three years later, having convinced William III that his services were indispensible, and reverted to Protestantism. He soon regained his position of influence and successfully persuaded William to support a united Whig ministry. As yet without office, he was appointed lord chamberlain and one of the lords justices in 1697, but the general distrust in which he was held, even by the Whigs, compelled him to resign these offices later in the year. Sunderland is generally considered one of the craftiest politicians of English history.

Robert Spencer was succeeded in the earldom by his second son, Charles Spencer, third Earl of Sunderland (1674-1722), known equally for his library of rare books and for his statesmanship. He entered Parliament in 1695, and in 1700 married Lady Anne Churchill, daughter of the earl (later duke) of Marlborough, a step of political importance, for his father-in-law was thus drawn toward the Whigs. In 1705 he was appointed envoy extraordinary to Vienna and the following year was named secretary of state for the southern department, becoming a member of the powerful Whig junto of five; but, through the machinations of the High Church Tories and his rival Harley, he was dismissed by Queen Anne in 1710. Throughout the remainder of Anne's reign Sunderland was in communication with the court of Hannover and their agents, and on the accession of George I in 1714 he was made lord lieutenant of Ireland, though he had hoped to be named one of the lords justices. The following year he exchanged his viceroyalty to join the cabinet as Lord Privy Seal and in 1717 succeeded in obtaining the dismissal of Walpole and Townshend and his own appointment as First Lord of the Treasury. He was forced to resign in favor of Walpole in 1721, owing to his connection with the South Sea Bubble, but continued to have great influence with George I. Sunderland's library at Althorp was described as the finest in Europe. His eldest son, Robert, succeeded him in the earldom, and on the latter's death in 1729, his second son, Charles (1706-1758), succeeded as fifth Earl of Sunderland and, through his maternal aunt, Henrietta, Duchess of Marlborough, as third Duke of Marlborough. Sunderland's third son, John, became founder of the cadet branch holding the earldom of Spencer.

**Earls of Spencer.** John Spencer (1734-1783), son of John Spencer, the youngest son of the third earl of Sunderland, was created earl of Spencer in 1765. He was succeeded by his son, George John (1758-1834), who was Lord of the Admiralty from 1794 to 1801 in the Pitt ministry and was largely responsible for the great naval victories at St. Vincent and Camperdown, as well as for singling out Nelson for independent command and sending him into the Mediterranean to win the Battle of the Nile. He was home secretary in 1806-1807. His eldest son, John Charles (1782-1845), Viscount Althorp, succeeded as third Earl Spencer in 1834. On entering Parliament in 1804, Althorp supported Pitt, later joining the advanced Whig Party, and, after the close of the war in 1815, gave a strong ear to the grievances of the working classes. In 1830 he became the leader of the Whig opposition, and on Wellington's resignation was named Chancellor of the Exchequer and leader of the House of Commons in the Grey ministry. He showed great zeal in working for the final passage of the Reform Bill, but with the rise of Peel his influence declined, though he retained office until 1834. He was succeeded in the title by his brother Frederick (1798-1857), whose son, John Poyntz Spencer (1835-1910), became fifth earl. The latter entered Parliament in 1857 and in 1868 was named lord lieutenant of Ireland, where he earned a reputation for firmness in maintaining order. He left Ireland on the fall of the Gladstone ministry in 1874 and, on the formation of the second liberal ministry in 1880, joined the cabinet as Lord President of the Council, but in 1882 he was reappointed to his former position in Ireland. His severity in punishing the Phoenix Park murderers of Lord Frederick Cavendish made him unpopular with the Irish, but he succeeded in restoring order. He resigned in 1885 and the following year again took office as president of the council in Gladstone's third ministry, supporting the latter's Home Rule Bill. He was First Lord of the Admiralty, 1892-1895, in Gladstone's fourth ministry, and from 1902 to 1905 was liberal leader in the House of Lords.

**Dukes of Marlborough.** The Spencer family fell heir to the dukedom of Marlborough in 1733, on the death of Henrietta, Duchess of Marlborough, daughter of the first duke and maternal aunt of Charles Spencer (1706-1758), fifth Earl of Sunderland and third Duke of Marlborough. *See also* MARLBOROUGH, EARLS AND DUKES OF. C. W. D.

**SPENCER, HERBERT** (1820-1903), English philosopher, was born at Derby on April 27, 1820. In his philosophy he was a champion of evolutionism, *laissez faire,* and the conception of philosophy as the unification of all sciences, and he highlighted these and other intellectual currents of his age. A complete lack of formal schooling and an impatience with the books of his predecessors made him rely on getting his knowledge wherever he could.

The key to his system of unified science, *First Principles* (1862), maintains in its opening chapters that nothing can be known of ultimate reality. This Unknown lies beyond the field of scientific investigation; religion merely rationalizes and reveres it in metaphor. The second part of this volume sets forth a cosmic theory of evolution which, he holds, is a universal principle underlying and summarizing all fields of inquiry. In 1852, seven years before the publication of Darwin's *Origin of the Species,* he had already brought out an essay, *The Development Hypothesis,* elaborating an earlier form of evolutionary theory by Von Baer. From basic laws of physics and from the idea of change, Spencer proceeds to define evolution as "an integration of matter and a concomitant dissipation of motion; during which the matter passes from an indefinite, incoherent homogeneity to a definite, coherent heterogeneity; and during which the retained motion undergoes a parallel transformation." All things have a common origin, but by the inheritance of characteristics acquired in adapting themselves to their environment, they become differentiated; when everything is adapted to its environment, a coherent, ordered universe emerges. Ultimately each thing will achieve complete adaptation, but such a state is unstable. The final stage of evolution is therefore but the first stage of dissolution, and then, in a great cycle, dissolution is followed by evolution again.

The key principles of what he called the Synthetic Philosophy were thereby stated at the very outset of Spencer's program; succeeding volumes needed only to interpret the particular sciences in terms of them. *Biology* followed (2 vol.

1864-1867), then *Psychology* (2 vol. 1870-1872), *Sociology* (3 vol. 1877-1896), and *Ethics* (2 vol. 1892-1893). Spencer's major contributions to scientific enterprise were in sociology, on which he published two other treatises, *Social Statics* (1850) and *The Study of Sociology* (1873), and eight volumes of classified data. Societies are described as evolving organisms similar to biological organisms. They may organize and control their own processes of adaptation, and thereby develop into militaristic states; or they may permit free and plastic adaptation, and thereby develop into industrial states.

The inevitable course of evolution, however, makes adaptation "not an accident but a necessity." As a consequence of his faith in the cosmic force of evolution Spencer defends a social philosophy of *laissez faire*. The individualism underlying this philosophy is succinctly expressed in the *Ethics*, wherein "every man is free to do what he wills, provided he infringes not the equal freedom of any other man." His *Autobiography* (2 vol. 1904) again reveals him to be an ultra-individualist both by temperament and heredity, a man of great self-discipline and productivity, but with little of humor or poetry about him. He died at Brighton on Dec. 8, 1903. A. G. Sm.

**SPENCER,** a city in northwest Iowa, the county seat of Clay Co., situated at the confluence of the Little Sioux and Ocheyedan rivers, about 80 mi. northeast of Sioux City. Founded in 1871, the community was incorporated in 1880. In June 1931 a fire practically destroyed the business district, causing approximately $2,000,000 worth of damage. Within a year most of the section was rebuilt. A mayor and council govern the city of Spencer. Of interest is a large county fair held every September in Spencer. Spirit Lake, the scene of an Indian massacre in 1857, is 18 mi. north. The Chicago, Milwaukee, St. Paul and Pacific and the Minneapolis and St. Louis railroads provide transportation. Spencer is the trade center and shipping point for a region where the growing of corn and soybeans and the raising of hogs and cattle are important. The local industries, which are dependent on the district's agricultural interests, process feed, meat, and dairy products. Pop. 1950, 7,446.

**SPENCER,** a town in Worcester Co., in central Massachusetts, located about 10 mi. west of Worcester. It is served by the New York Central System. The chief industry is the manufacture of shoes. William Howe, inventor of the truss bridge, Tyler Howe, maker of the spring bed, and Elias Howe, inventor of the sewing machine, were all born in Spencer. The town was founded by Samuel Bemis in 1721 and incorporated in 1753, and has the town meeting form of government. Pop. 1950, 5,259.

**SPENDER, STEPHEN** (1909- ), English poet and critic, was born in London, Feb. 28, 1909, and educated at University College School and at University College, Oxford. A member of the revolutionary group of writers that included W. H. Auden, Christopher Isherwood, Cecil Day Lewis, and Louis MacNeice, he first attracted notice with *Poems* (1933). Several pieces in this volume derive technically from Walt Whitman and D. H. Lawrence; praising labor and denouncing capital, they are more political and more violent than most of the work of Spender's friends. Other poems in the volume on pylons, trains, and aerodromes, for example, reveal Spender's lyric power. *Vienna* (1934), a long poem, celebrates the abortive revolution of Viennese socialists in 1934 against the Dollfuss government. In 1938 Spender published *Trial of a Judge*, an antifascist verse play in the manner of Auden, and, after a visit to Spain, he edited with John Lehmann *Poems for Spain* (1939), an anthology occasioned by the Spanish Civil War. In *Forward from Liberalism* (1937) he had maintained the individualism of the artist against Marxist demands; and after the German-Soviet pact of 1939, like most English leftists, he modified his political sympathies. Spender's subsequent volumes of poetry, *The Still Centre* (1939), *Ruins and Visions* (1942), and *Poems of Dedication* (1946), more self-centered than his earlier works, lack their conviction and power.

From the outset of his career Spender showed himself to be an excellent critic, and *The Destructive Element* (1935), a volume of essays on contemporary literature, attracted almost as much attention as his poems. In 1940 he became associated with the magazine *Horizon*, to which he contributed annual surveys of poetry. Among his works of fiction are *The Burning Cactus* (1936) and *The Backward Son* (1940). *European Witness* (1946) is a survey of postwar Germany. W. Y. T.

**SPENGLER, OSWALD** [shpɛ′ŋlər] (1880-1936), German historian and philosopher, was born May 29, 1880, at Blankenburg in the Harz Mountains. He studied philosophy, history, mathematics, and art at the Universities of Munich and of Berlin, where he received his doctoral degree in 1904. He started his academic career as a teacher of mathematics at the University of Munich.

In 1918 there appeared the first volume of his remarkable philosophy of history, *Der Untergang des Abendlandes* (*The Decline of the West*, 1926-1928), the second volume appearing in 1922. In this, his most important work, Spengler predicted the disintegration of Western European and American civilization after a violent "age of Caesarism," arguing by detailed analogies with other civilizations and interpreting history as the life of nine organic cultures: Egyptian (3400 B.C.-1205 B.C.), Indian (1500 B.C.-1100 B.C.), Chinese (1300 B.C.-A.D. 200), Classical (1100 B.C.-400 B.C.), Byzantine (A.D. 300-1100), Aztec (A.D. 1325-1500), Arabian (A.D. 300-1250), Mayan (A.D. 600-960), and Western (A.D. 900-2400). With a great variety of factual material Spengler attempts to substantiate two propositions about these cultures. First, all cultures follow the same pattern of growth and decay in approximately the same length of time. They pass through the stages of pre-culture, culture, and civilization, and are marked by identical crises. Alexander, for example, plays the same role in Classical culture as Napoleon in Western culture; Pythagoras as Luther; Aristotle as Kant; Stoicism as Socialism. Second, each culture has its unique "soul," or pattern of experience and creation, expressed in its forms of art, thought, and action. Thus the Western "Faustian" soul is characterized by a yearning for infinity, which is equally expressed in the Gothic cathedral, the infinitesimal calculus, the music of Bach, world-wide imperialistic diplomacy, the radio, and modern techniques of credit banking.

In several other books, of which perhaps the most significant are *Der Mensch und die Technik* (1931) (*Man and Technics*, 1932) and *Jahre der Entscheidung* (1933) (*Hour of Decision*, 1934), Spengler wrote of the political and spiritual predicament of Germany in the aftermath of World War I. M. C. Be.

**SPENSER, EDMUND** (c.1552-1599), English poet, was born in London of humble stock, though his family was related to the wealthy house of Sir John Spencer of Northamptonshire. Though poor, he was somehow helped to get the best available education of the time, first at the Merchant

Taylors School under the great teacher Richard Mulcaster, then at Pembroke College, Cambridge. His talents were early recognized, and won him introduction to employment and patronage under the Bishop of Rochester, and later under the Queen's favorite, the Earl of Leicester. Thus he found access to the Court, and was brought into association with Sir Philip Sidney, Sir Fulke Greville, and other literary men. In 1579 he published *The Shepherd's Calendar* which revealed to the literary world undiscovered poetical resources in the English language of the time. It met ready and long-lived success. Spenser's hopes of preferment were running high, when for some unknown reason, perhaps imprudent utterance, he was sent out of the way to Ireland as secretary to Lord Grey. In that rough and turbulent country, except for two visits of a year or more in London, he lived out the rest of his hard life, solaced by the joy of poetical composition and the wild beauty of Ireland, but irked by unstable conditions and the deferred hopes of his ambitions. His last ten years he spent at Kilcolman, his estate of three thousand acres and a castle, about thirty miles north of Cork. Late in 1598, during the Tyrone rebellion, his castle was burned, and Spenser escaped to London, to die there Jan. 13, 1599. He was buried in Westminster Abbey.

Spenser was twice married, first about 1580 to an unknown woman who died early, again to Elizabeth Boyle in 1594. He had at least three children. In various poems he has recorded an unrequited passion and "long affliction" for a fair unknown disguised under the name Rosalind. His nature was composed of two warring elements, strong worldly ambition and high poetic idealism. As a man of the world he had a qualified success. Queen Elizabeth appreciated him, and probably would have done more for him had it not been for her shrewd but prosaic minister, Lord Burghley. Throughout his rough career his production of poetry was prolific, and probably constant, though he published only on occasion of his visits to London, but then in quantity. In his thirty active years he produced over 47,000 lines of published verse, besides more than twenty unpublished works now lost. He began at about seventeen with some precocious translations of twenty-one sonnets from French and Italian. Ten years later came *The Shepherd's Calendar,* and after ten more years, on his first return to London, three books of his *Faerie Queene* (1590) and his *Complaints* (1591). *Complaints* was a selection mostly of studio pieces, elegies, visions, allegories, and translations, which had been produced during the previous years. One of them, however, *Mother Hubberd's Tale,* a beast fable, was a bitter satire on conditions in Church and State, in part aimed at Lord Burghley and his son, Sir Robert Cecil. It hurt his chances for preferment, and perhaps had something to do with his going to Ireland, though the Queen herself was delighted with his *Faerie Queene,* well knowing what so great and promising a poet was worth in lending luster and fame to her reign. The year 1591 also saw the private publication of *Daphnaida,* a lovely if formal elegy for the dead wife of a young courtier. In 1595 appeared his charming autobiographical pastoral poem, *Colin Clout's Come Home Again,* together with *Astrophel,* a long-delayed, perfunctory elegy for Sir Philip Sidney; and in the same year his *Amoretti and Epithalamion,* consisting of eighty-six love sonnets, some of the best of that sonneteering generation, and one of the most glorious wedding-songs ever devised, in celebration of his second marriage. In 1596, again in London, he published Books IV-VI of *The Faerie Queene,* and reissued Books I-III. Also in 1596 appeared his *Four Hymns,* in honor of Love, Beauty, Heavenly Love, and Heavenly Beauty, a quartette embodying, in lofty and varied word-music hitherto unheard in English, the Platonic ideas of secular love and beauty and of the Christian mystical union with God which were still prevalent in Italy and France. Lastly, in 1596 appeared *Prothalamion,* a much admired betrothal ode in honor of a double spousal of four young aristocrats. Thirty-four years after his death his long prose treatise, *A View of the Present State of Ireland,* saw the light. It was written near the end of his life, and recommended rather drastic procedure with that unhappy country. He had planned twelve books in all for his *Faerie Queene,* but only two cantos, a possible fragment of a seventh book, have been found.

Charles Lamb called Spenser the poet's poet. He may have said more than he realized, for the epithet holds surprisingly. One does not have to be a poet to appreciate Spenser, but one must have enough poetry in him to respond to the word-music of Spenser, to his shifting color and pageantry, to his power of suggestion, where more is meant than meets the ear, and one should have a mind for ideas and conceptions that outstrip the mere limits of mundane life. Perhaps Lamb was thinking only of Spenser's power to make other men sing. Spenser discovered a new music in the rejuvenated English language of his time, and called it forth in a wide variety of pitch and cadence. Other poets have caught his strains and echoed them, from Marlowe and Shakespeare to Tennyson and T. S. Eliot. The "Spenserian stanza" of eight five-stress lines plus one six-stress line, rhyming *ababbcbcc,* is the most important and original metrical invention by any single English poet. It has since been used by Pope, Thomson, Burns, Scott, Wordsworth, Byron, Shelley, Keats, Tennyson, and a host of lesser poets.

The England of Elizabeth was provincial and knew it. Spenser was its richest importer and disseminator of poetic materials and ideas. He engrafted in English poetry the Italian Platonic ideas of love and beauty, imagery from Petrarch, legend from Ariosto and Tasso, theories of the art and language of poetry from France; he reopened infinite poetic resources from the Latin and Greek Classics; and he revived the neglected wealth of material from English history and the tradition of chivalry. All this and more he imbued with native English vigor and quality, and under his hand it became poetry with the peculiar power of enriching the poetry of others. He idealized England and the Queen, and was convinced that if he could kindle the imagination of his fellow countrymen by his poetry, he could thus bestir them to a realization of their greatness in the making of a better world. He believed in the subtle kinetic power of poetry over the minds and wills of men.

A high idealist, Spenser, like Dante and Shelley, found allegory and parable his natural means of expression. But he clothed them with splendor of pageantry and variety of music, with charm of manner and vigor of action, and with the reality of essential values, so that they find response not only in many a professed poet, but in any one who has poetic sense. *See also* FAERIE QUEENE, THE; SHEPHERD'S CALENDAR, THE.

C. G. O.

**SPENSERIAN STANZA,** so named from Edmund Spenser's use of it in *The Faerie Queene,* an ample, sonorous verse form composed of nine lines, the first eight in iambic pentameter and the last an alexandrine, in iambic hexameter. The rhyme scheme is *ababbcbcc.*

> At length they spide, where towards them with speed
> A Squire came gallopping, as he would flie;
> Bearing a little Dwarfe before his steed,
> That all the way full loud for aide did crie,

That seem'd his shrikes would rend the brasen skie:
Whom after did a mightie man pursew,
Ryding upon a Dromedare on hie,
Of stature huge, and horrible of hew,
That would have maz'd a man his dreadfull face to vew.

The Spenserian has been most used for romance in the grand style, and for philosophic poems. It has a sustained rhythmic sweep, and the final long line adds an epic dignity. It was imitated by Spenser's followers in the seventeenth century, and again by Thomson, Shenstone, and others in the mid-eighteenth. Burns, Byron, and Tennyson have all written important poems in this great stanza, but the best-known modern examples are in Keats's *The Eve of St. Agnes* and in Shelley's *Adonais.* R. Bn.

**SPERM.** *See* Man, Functional Anatomy of (*The Reproductive System*); Reproduction, Animal; Reproduction, Human (*Reproductive Function in the Human Male*).

**SPERMATOGENESIS.** *See* Reproduction, Human (*Reproductive Function in the Human Male*).

**SPERM WHALE.** *See* Whales.

**SPERONI, SPERONE** [spero'ni] (1500-1588), Italian writer and linguist, was born at Padua in 1500. He studied at Bologna, taught logic at Padua until 1528, and came to enjoy a great reputation as a man of letters. He died at Padua in 1588.

Speroni wrote lyrics, essays on the *Aeneid,* the *Divine Comedy,* and the *Orlando Furioso,* several dialogues, and the tragedy *Canace,* composed in 1542 and published in 1546. *Canace* purported to be a perfect imitation of Greek tragedies according to Aristotle's rules—a claim which was soon challenged and started a literary war that lasted for fifty years. Some of the characteristics of the play are an excess of horror, an absence of moral aims, and some important metric reforms. Of Speroni's dialogues, which include *Delle lingue, Della retorica, Della cura familiare, Dell'amore, Della dignità,* and *Delle donne,* the most important is *Delle lingue.* In this he followed Dante and Bembo in defending the new Italian *volgare* against Latin and Greek, maintaining that it was perfectly capable of fulfilling the artistic function of a great new language. Speroni's dialogue had a great influence in Italy and also in France, where it directly inspired Du Bellay's famous *Deffense et illustration de la langue françoyse* (1549). G. B.

**SPERRY, ELMER AMBROSE** (1860-1930), American electrical engineer and inventor, was born in Cortland, N. Y., on Oct. 12, 1860. He attended the State Normal School in Cortland and Cornell University. Sperry perfected an electric arc lamp in 1879 and in 1880 organized the Sperry Electric Co. in Chicago to manufacture arc lamps and dynamos. He invented the first electric chain mining machine in 1888. He also designed an electric locomotive and an electric driving apparatus for trolley cars, and as a result of these developments founded the Sperry Electric Railway Co. in 1890. Sperry sold the company to General Electric Co. in 1894. At the turn of the century, Sperry founded an electrochemical laboratory in Washington, D. C., where, with the assistance of C. P. Townsend, he developed a process for the manufacture of pure caustic soda and perfected a new and improved method for salvaging tin from waste metal products. In 1918, Sperry invented a high-intensity arc searchlight which was several times as bright as any previous searchlight. This was presently adopted for military and naval use.

Sperry's greatest fame came from his adaptations of the gyroscope to practical problems. He organized the Sperry Gyroscope Co. in Brooklyn, N. Y., in 1910 and remained as its head until 1929. He invented the gyrocompass, which is based on the rotation of the earth and which superseded the magnetic compass. He developed electrically driven gyro-stabilizers for maintaining ships on an even keel and for keeping airplanes in a horizontal position. Sperry also designed gyro-directed aerial torpedoes, gyro pilots for steering ships automatically, and devices that dealt with submarine detection and anti-aircraft gunnery. During his lifetime, he took out about 400 patents.

Sperry published numerous papers and received many honors. In 1914, he was awarded a prize by the Aero Club of France for his airplane stabilizer. The French Institute decorated him with two medals, in 1914 and 1929, and he was given the John Fritz Medal in 1927. Sperry was the recipient of three honorary doctorates and was decorated by the tsar of Russia and the emperor of Japan. He was a founder and charter member of the American Institute of Electrical Engineers and of the American Electrochemical Society. Sperry died in Brooklyn, N. Y., on June 16, 1930. *See also* Gyrocompass; Gyroscope. I. B.

**SPEYER** or **SPIRES** [shpai'ər, spai'ərz], an industrial town in the state (*Land*) of Rhineland-Palatinate, in southwestern Germany, the former capital of the Bavarian Palatinate. It lies in the broad Rhine River valley, astride the mouth of the Speyerbach, in a fertile agricultural region. It was known to the Romans as Augusta Nemetum and to the Gauls as Noviomagus. Located on an easy migration route, Speyer was frequently destroyed by barbarians during the *Völkerwanderung.* It was a bishopric in the seventh century and became a free imperial city in the thirteenth century; it was at the Diet of Speyer in 1529 that adherents to the Reformed faith received the name of Protestants. Destruction of Speyer by the French in 1689 was so severe that recovery came only in the twentieth century. The cathedral, the largest Romanesque church in Germany, dates from the eleventh century; it has been repeatedly destroyed and contains the remains of a number of German emperors. From 1801 to 1814 Speyer was part of Donnesberg. Industries include breweries, wine cellars, brickyards, iron works, cotton-spinning mills, and tobacco and shoe factories. Pop. 1953, 35,000. C. C. H.

**SPEYER, DIETS OF,** formal public assemblies of the princes and councilors of the Holy Roman Empire, held several times during the Reformation at Speyer (Bavaria), notably in 1526 and 1529. In the Diet of 1526 the Lutheran princes, who for their common defense had formed the Alliance of Torgau in May 1526, secured the decision that pending the convocation of a general council each might adopt with regard to the Edict of Worms (which in 1521 had forbidden all religious innovations) such attitude as he could justify before God and emperor. Territorial rulers thus received implicit permission to introduce the Reformation into their lands. In the Diet of 1529, Pope Clement VII and Emperor Charles V being no longer at war and the reformers less solidly united, the Recess of 1526 was rescinded, the Edict of Worms was reaffirmed, and it was decreed that while Lutheranism might remain where it was established, it could not be extended, whereas Catholicism was to be everywhere free. The Reformer princes and fourteen important cities protested. The name Protestant dates from this protest made in behalf of Lutheranism. N. J. T.

HAMILTON WRIGHT

*THE GREAT SPHINX OF GIZEH*

**SPEZIA, LA.** *See* La Spezia.

**SPHALERITE** [sfæ′lərait], or zinc blende, is the outstanding ore of zinc. In composition, it is zinc sulphide, ZnS. Up to eighteen per cent of iron may also be present. The color of the pure zinc sulphide is white, but enough iron is invariably present to color sphalerite yellow, brown, red, or black. The miners' term for red sphalerite is ruby jack, and for the more common black variety, black jack. Regardless of color, the streak of sphalerite is light yellow. Another distinctive characteristic is six directions of cleavage. Black jack has a metallic luster, but the common brown sphalerite has a distinctive resinous appearance. Geologically, sphalerite is found under relatively low temperature conditions. The large Mississippi Valley zinc deposits are of disputed origin. The depositing solutions were either circulating ground waters or magmatic waters of exceptionally low temperature type. Elsewhere, as in the Rocky Mountain area, sphalerite occurs with galena in veins of the low and intermediate temperature type. It is also found, but much more rarely, in contact metamorphic deposits. The United States is the leading producer of zinc. Over one fourth of the domestic output is from the Joplin or Tri-state District, which includes adjoining corners of Missouri, Kansas, and Oklahoma. Idaho and New Mexico may also be included as valuable sphalerite-producing regions within the United States. Large foreign sources of sphalerite are found in Canada, Mexico, Australia, Germany, Poland, and the U.S.S.R.

K. K. L.

**SPHENE** [sfi′n], formerly called titanite, is calcium titanosilicate, $CaTiSiO_5$. The name comes from the Greek word meaning "wedge," in allusion to the characteristic shape of the monoclinic sphene crystals. This mineral is commonly brown in color, more rarely, oily green. The luster ranges from resinous to brilliant. Sphene occurs as a microscopic accessory mineral in different types of igneous rocks, and in larger crystals in pegmatites. It is mined on the Kola Peninsula, U.S.S.R., as an ore of titanium. K. K. L.

**SPHENOPSIDA.** *See* Plant Systematics.

**SPHERICAL TRIGONOMETRY.** *See* Trigonometry.

**SPHEUOPSIDA.** *See* Horsetail; Plant Systematics.

**SPHINX** [sfɪ′ŋks], in ancient Egypt, the stone figure of a lion in a recumbent attitude, the upper part of the body being that of a human, usually male rather than female. In Egypt, sphinxes appear to have been set up along avenues forming the approaches to temples.

The most celebrated among the Egyptian sphinxes is that of the colossal Great Sphinx at Gizeh guarding the entrance to the Nile Valley. With the exception of the paws, it is constructed of one block of stone. The statue was intended to represent the god Hor-em-khu or Horus, and is believed to antedate the IVth Dynasty, which began about 2700 B.C. In some of the Egyptian sphinxes the upper part of the body was that of a ram, the *Crio*-sphinx, or of a falcon, the *Hieraco*-sphinx.

Both the legend and the figure of the sphinx were probably introduced into Greece from Egypt or Ethiopia, but the figure of the sphinx became somewhat modified in Greek mythology and art. C. W. D.

**SPHINX** (Gr. Σφιγξ, the "Strangler"), in Greek mythology, a winged monster with the body of a lion and the head and breast of a woman. According to the myth, the Sphinx destroyed the passersby from the Greek city of Thebes when they failed to guess her riddle: "What is four-footed in the morning, two-footed at noon, three-footed in the evening?" Oedipus solved the riddle by replying: "Man, who in childhood creeps on hands and knees, in manhood walks erect, and in old age uses a staff." The Sphinx, hearing this, threw herself from a rock and perished, and Oedipus thus became the liberator of Thebes and was made its king. *See also* Oedipus. G. E. D.

**SPHINX MOTH,** or hawk moth, the common names given to any moth of the family Sphingidae. All are heavy-bodied and most are streamlined in shape. The wings are long and narrow, with strong veins, and the antennae are short and densely plumose. These moths are fast flyers, and

are among the few kinds of insects that can fly backwards. The proboscis is long, enabling the moth to suck nectar from deep-seated nectaries, hovering before the flower during the process. This habit of the moth has frequently led to confusion with hummingbirds, especially when seen in poor light. Most of the hawk moths are nocturnal, or fly

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*TOMATO SPHINX MOTH*

at dusk, and many kinds are attracted to light. However, there are day fliers among them, including the clearwings or hummingbird moths, of which *Hemaris thysbe* is a common species. The death's-head moth, the tobacco worm, and the tomato worm all belong to this group. C. H. Cu.

**SPICA** [spai'kə], also designated Alpha (*a*) Virginis, the brightest star (magnitude 1.21) in the constellation Virgo. Its position on the celestial sphere is right ascension, 13 hr. 22 min.; declination, — 10°.9. In color it is blue-white. Its distance is considerably over 100 light-years; its intrinsic luminosity, several hundred times that of the sun. Spica is a spectroscopic binary, or double star, the revolution period of which is four days. *See also* VIRGO. J. H. P.

**SPICEBUSH,** a genus, *Lindera,* of the laurel family having about 60 species in eastern Asia and North America. These plants are aromatic trees or shrubs, some yielding an oil used in perfumery. The name is usually applied to the common spicebush, *L. benzoin,* a graceful, branching shrub growing as high as 15 ft., native to New England and to regions southward and westward. It has delicate clusters of small yellow flowers, appearing in early spring before the leaves, and red fruit ripening in the late summer. It is also known as the benzoin tree. J. C. Wis.

**SPICE ISLANDS.** *See* MOLUCCA.

**SPICES,** a group of pungent or aromatic vegetable substances used chiefly as seasoning and as preservatives. Some of these are clove, cinnamon, pepper, mustard, nutmeg, mace, cumin, caraway, rosemary, basil, thyme, dill, marjoram, allspice, ginger, paprika, cardamon, and many others. Their flavor depends on the volatile oils they contain. *See also* FOOD FLAVORS; FOODS AND COOKERY; *and articles on individual spices.* J. A. Bo.

**SPIDER,** a common animal of the class Arachnida, phylum Arthropoda, related to scorpions, mites, and daddy longlegs. Spiders are well known because of their abundance and because of their web-building instinct. They are mostly small animals, ranging in length from 1/25 in. to over 2 in. in the largest tarantulas; the great bulk of them, however, range from 1/8 in. to 1/2 in. The body is divided into two distinct parts, joined by a narrow pedicel. The front part is the cephalothorax; the hind part, the abdomen. The cephalothorax is covered with a hard shield above, which typically bears eight simple eyes on the front part. In some species the eyes are reduced to six, four, or two, and to none at all in the case of a number of cave species. The relative sizes and arrangement of the eyes vary with the different families. There are six pairs of appendages attached to the cephalothorax: a pair of chelicerae, composed of two segments, a base and a moveable fang, used for grasping prey; a pair of pedipalpi, which ordinarily project out in front as feelers but which in the adult males are modified into secondary reproductive organs for transmitting semen to the females during mating; and four pairs of walking legs, which are made up of seven segments each and bear two or three claws on the end. On the underside, between the

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*GARDEN SPIDER*

bases of the legs, is a hard shield, the sternum. The abdomen is usually soft. It bears the spinnerets, from which the silk is spun; these are usually six in number. The silk is used by the spider in making webs, building retreats, making egg cocoons, laying draglines, and ballooning. Also on the underside of the abdomen are the openings for the reproductive and respiratory organs. Breathing is done by means of spiracles, trachea, tubes, and leaflike book lungs. These thin leaves are amply supplied with blood, and gaseous exchanges take place through their surfaces.

Spiders are numerous, both as regards individuals and species. When the species are all known, the number for the world will undoubtedly exceed 50,000 and may approach 100,000. They live at all latitudes and altitudes where insects occur, and inhabit all important islands as well as the continents. They occupy a great variety of habitats, living

in burrows in the ground; in crevices and under bark of trees; under stones, leaves, or trash on the ground; and in houses and basements, where the abandoned webs frequently collect dust. Their behavior patterns also vary greatly; some build webs for capturing their prey, whereas others hunt without snares. Of the more than sixty recognized families of spiders, only two are the geometrical orb weavers so commonly associated with spiders.

Although nearly all spiders possess poison fangs, which are helpful in subduing their prey, few of them are dangerous to man. Except for the black widow and its close relatives and some of the larger tarantulas, they can be ignored by man from the standpoint of poison. All spiders live on insects and other small animals, which they capture alive and from which they suck only the juices. Most spiders live only one season, completing their life cycle in a single year, though a number live two years, and some, notably the tarantulas, may live five or more years. *See also* BLACK WIDOW SPIDER; GARDEN SPIDERS; GOSSAMER; MYGALOMORPHAE; TARANTULA; TRAP-DOOR SPIDER. W. I.

**SPIDER CRAB,** one of a group of true crabs, the Oxyrrhyncha, most of which are characterized by long, slender legs. The typical spider crabs, and by far the greatest number of species of the group, belong to the family Majidae. Some of them are among the slowest moving of Crustacea, depending in many cases upon their camouflaging habits to avoid capture. Bits of seaweed and sedentary animals such as sponges and alcyonarians are snipped off with the claws and carefully placed upon the crab's back, where they are held in place by means of regularly placed hooked hairs. Since these "decorator crabs," as they are sometimes called, seem able to choose marine organisms which will flourish after transplanting in this manner, they are soon effectively concealed beneath a portable garden which blends into the general surroundings. The largest of Crustacea, the giant crab of Japan which may span more than 12 ft., is also a spider crab but does not camouflage itself. Many tropical species, on the other hand, are less than 1 in. across the back. F. A. C.

**SPIDERFLOWER,** the common name of a genus, *Cleome,* of the caper family, having about 30 species widely found, usually in tropical regions. Spiderflowers are chiefly

*THE SPIDERFLOWER* (CLEOME SPINOSA)

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annual herbs, some of which are shrubby species, often strong-scented, and sticky to the touch. Some are cultivated as ornaments, especially the spiny spiderflower, *C. spinosa,* which grows as high as 4 ft. and has long, flowering stalks bearing rose-purple or white flowers which have conspicuously long stamens. Various good garden varieties have been introduced. J. C. Wis.

**SPIDER LILY,** a group of plants in the genus *Hymenocallis,* of the amaryllis family, native to southern United States and tropical America. The large terminal flowers,

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*SPIDER LILY, HYMENOCALLIS*

which occur either singly or in clusters at the summit of a solid scape, rise directly from the bulb. The showy flowers are white, pink, or purplish. The segments of the perianth are reflexed and exceedingly narrow, and the long filaments of the stamens are united at the base into a cup-like crown. Several species are in cultivation as greenhouse plants, or as outdoor specimens in warm climates. They flower in spring or summer, and are long-lived. C. H. Wo.

**SPIDER MONKEY,** the most typically arboreal of the American monkey, *Ateles,* known locally as coaitas. They are less active in the trees than the gibbons and some Old World monkeys, but they are especially adapted to tree life. The tail is long, as much as three times the length of the trunk, prehensile, and naked along the underface of the tip. The arms and legs are greatly elongated, as the name suggests. The thumb is so short as to be nonfunctional, the hand being used as a hook in swinging through the trees. The body is slender, and has a small, prominent belly. The head is small and round; the eyes large and expressive; the hairy covering coarse and straight, not woolly. Most of the hair of the head is directed forward.

The tail of this monkey serves as a fifth hand, being used to feel for a branch to grasp, or to draw objects within reach of the hand. When not in use, the tail is carried erect or over the back.

Spider monkeys travel in bands of twenty to thirty through the forest canopy. They have been known to band with capuchin monkeys. They are silent monkeys, but when dis-

turbed will sometimes hurl branches and fruit at men on the ground. Their food consists of fruit and leaves. They make good pets; the mobility of their facial muscles and their quiet

COURTESY OF THE AMERICAN MUSEUM OF NATURAL HISTORY

*SPIDER MONKEY*

gymnastics lend an interest lacking in many other monkeys. In most parts of their range, they are esteemed as food.
R. T. H.

**SPIDERWORT,** a genus, *Tradescantia,* of the spiderwort family, of which about 35 species are scattered from Manitoba to Argentina, and about 15 grow in the United States. These plants are soft, succulent, perennial herbs. They have narrow, alternate leaves, and red, blue, or white flowers, usually in clusters. The Virginia spiderwort, *T. virginiana,* has narrow basal leaves and a flower stalk 1 to 3 ft. high, which bears a long succession of violet-blue flowers, often 1 to 2 in. in diameter. *See also* WANDERING JEW.
J. C. Wis.

**SPIKE GRASS,** a common name for several species of the grass family which bear rather conspicuous flowering spikes. Among them are *Leptochloa fascicularis, Distichlis spicata, Triglochin maritima,* and several species of *Uniola,* all found in North America, chiefly in coastal, marshy, and alkaline locations. *See also* ALKALI GRASS; SALT GRASS.
J. C. Wis.

**SPIKENARD** [spai′knərd; spai′knɑrd], a perennial Himalayan herb, *Nardostachys jatamansi,* of the valerian family. Its fragrant, musky rootstocks, or spikes, used in perfumery and ointments, are considered the source of the costly spikenard of biblical times. Several other plants are known locally as spikenard. American spikenard, *Aralia racemosa,* of the ginseng family, a woodland herb of eastern North America having spicy aromatic roots, was used by the Indians, medicinally and in beverages. J. C. Wis.

**SPINACH,** *Spinacia oleracea,* an annual of the goosefoot family, cultivated for its edible leaves. It is probably native to southwestern Asia. The shrub, to 2 ft. in height, bears large leaves growing in a cluster from the root. The small flowers are in axillary clusters and are followed by spiny capsulelike fruits containing the seeds. Spinach is essentially a cool-season crop, and is grown both as a spring and fall crop. The plant is of easy cultivation, growing in a well-drained and limed soil. Several varieties exist, including the round-seeded spinach, *S. oleracea* var. *inermis.* V. A. T.

**SPINAL CORD.** *See* COMPARATIVE ANATOMY; NERVOUS SYSTEM.

**SPINDLE TREE,** also called burning bush or strawberry bush, a genus, *Euonymus,* of the staff-tree family, which occurs in about 120 species, chiefly in the Northern Hemisphere, 6 of which are found in North America. They are deciduous, rarely evergreen shrubs or vines, with opposite leaves, usually brilliantly colored in the autumn, and with inconspicuous flowers and bright fruits. In Europe, the wood, which is tough and close-grained, is used for the manufacture of small tools and for other such purposes. The bark of the American species has medicinal properties. Because of the spindle tree's handsome foliage and fruits, many of the more hardy Asiatic species are used as ornamentals. The winged euonymus, *E. alatus,* a deciduous spreading shrub reaching a height of 8 ft., has corky wings on the twigs, small leaves, and purplish-red autumn foliage. *E. japonicus,* an upright shrub growing as high as 15 ft., is evergreen. *E. fortunei radicans,* native to Japan, is an evergreen climbing shrub growing to 20 ft. *E. americanus,* an upright shrub to 8 ft., is found from New York to Texas, and has brilliant pink fruits. J. C. Wis.

**SPINE** or **SPINAL COLUMN.** *See* MAN, FUNCTIONAL ANATOMY OF.

**SPINEL** [spinɛ′l], a mineral that is most commonly composed of magnesium, aluminum, and oxygen, $MgH_2O_4$. However, manganese, iron (both ferrous and ferric), and chromium may replace a part at least of the magnesium and aluminum. Spinel always crystallizes in octahedrons. Its hardness (8) is greater than that of any other octahedral mineral except diamond. The typical occurrence of spinel is as a contact metamorphic mineral, especially in magnesian limestones. It may also be an accessory mineral in basic igneous rocks. Spinel has no value except as a gem.

**Gems.** This mineral is often found in association with ruby and sapphire and is usually ruby-red or pink, but blue, green, brown, yellow, and even black spinels have been found. The gravel deposits of Ceylon yield fine specimens; other sources are Burma, Siam, Sweden, and Franklin County, New Jersey. Pleonaste, ceylonite, balas, gahno, and chloro are names that have been applied to varieties of this stone. This gem has often been confused with the true ruby. Two famous gems of history, the Black Prince ruby and the Timur ruby, are now known to be spinels. Gem spinel occurs in large sizes up to three hundred carats.

**Synthetic Spinel.** Spinel has been successfully reproduced by man. Synthetic spinel is manufactured in the same manner as synthetic ruby and sapphire. These gems are usually made in two colors—sapphire blue and aquamarine blue-green. Synthetic spinel has a slightly greater density and a higher index of refraction. The synthetic product has pronounced fluorescence when activated by X-ray radiation.

Genuine spinel may reveal no fluorescence or only a trace, when similarly tested. K. K. L.

**SPINET** [spɪ′nət], a musical instrument of the fifteenth to eighteenth centuries, identical in principle with the harpsichord (with which spinet was originally synonymous) but usually smaller, and rectangular in form rather than wing-

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*A SPINET OF MODERN DESIGN*

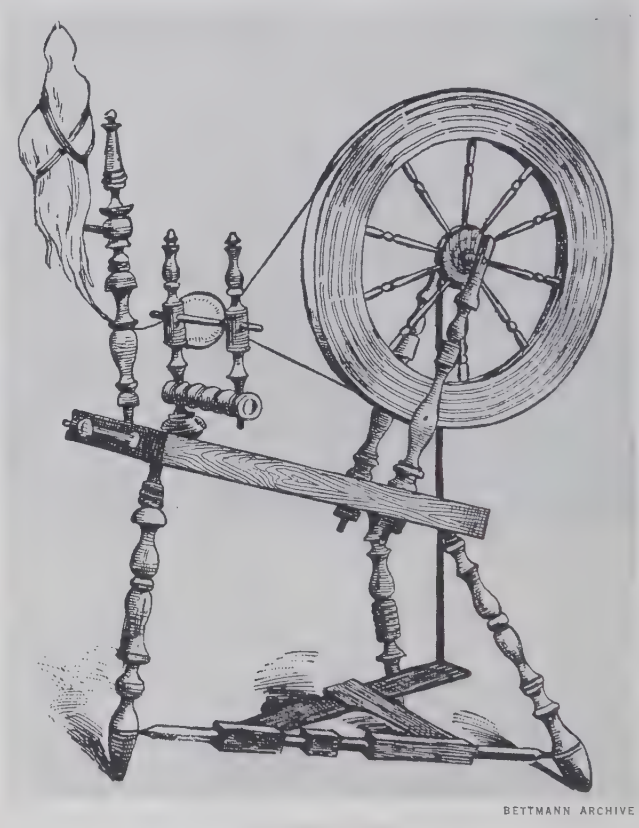
shaped. In modern piano-trade parlance, small, oblong pianos are sometimes called spinets in contrast to larger, heavier, wing-shaped grand pianos. *See also* HARPSICHORD. W. Li.

**SPINNING.** Spinning is a process by which fiber lengths are simultaneously overlapped and spiraled to gain length and strength. The principle is the same, from the crude cordages of the Stone Age down to the finest threads from modern machines. Twine and rope as binders made possible many advances of civilization—e.g., lashings on weapons and tools (for subsistence, defense, construction), hauling and hoisting heavy objects (stone architecture), lashings and fastenings on sailing ships (trade, exploration). Spun yarns are basic ingredients of the warm and cool clothing which permitted man to settle in varied, difficult climates.

The simplest method is thigh-spinning, whereby fibers are rolled down the right thigh under the right hand as they are fed in by the left. Some primitive peoples still use this method; ancient Egyptians substituted a thigh-shaped stone, while Greeks placed a curved tile over the knee.

The spindle is a short, pointed stick with a disc weight (whorl) as a flywheel. Fibers are drawn from stock in the left hand, slightly twisted to form a loose yarn (roving). The free end of the roving is wound on the spindle shaft, spiraling off its upper tip. The spindle is then twirled by the right hand and allowed to swing free. The whorl gives momentum and pulls down on the twisting fibers (drop-spindle spinning). A distaff held under the left arm may carry the stock of fibers, permitting the left hand more freedom to draw out new fibers. When a length of yarn is formed it is wound up on the spindle shaft (spooling), and the cycle of action is repeated. For delicate threads which could not sustain the swinging weight, the spindle is twirled with its lower tip resting on the ground or in a bowl (supported-spindle spinning). The spindle was in use 10,000 years ago; Egyptians made linen thread with the drop-spindle; in India supported-spindle spinning produced fragile cotton threads.

The simplest form of the spinning wheel is a plank on which a spindle is set horizontally in a revolving cylinder motivated by a belt around a large, hand-cranked wheel. The spinner feeds fibers to the spindle tip with the left hand while cranking with the right. When an arm's length of yarn is formed it is spooled on the spindle shaft, and the action-cycle repeated. Speed and control are gained, but spinning must stop for spooling. This device probably originated in India and diffused east and west; it was used in Europe by the early fourteenth century and continues in India and Indonesia for spinning cotton and wild silk.



BETTMANN ARCHIVE

*A SPINNING WHEEL*

Spinning and spooling were made simultaneous by a fifteenth century improvement, the addition of a flyer. The spindle shaft now serves as an axle on which are mounted a spool and the flyer. The flyer is U-shaped, its two arms extending beyond the spool. The roving to be spun passes through an eye in the spindle tip, over a hook on the flyer arm, and down to the spool. Spool and flyer have separate belts coming from the drivewheel, their pulleys of different diameters causing the flyer to revolve faster than the spool. When put in motion, the whirling flyer twists the roving into yarn while it moves on to the slower-turning spool. The addition of a treadle in the sixteenth century freed the right hand, the drivewheel now being propelled by footpower. A distaff set into the base plank brought stock fiber within the spinner's reach. This combination, mounted on a variety of frames but retaining the essential spindle, flyer, spool, distaff, and treadle, is the heritage of our "Colonial" spinning wheel.

Desire for quantity, uniformity, and speed in production

led to the development of machines with multiple spindles and spools. Leonardo da Vinci devised a hand-cranked machine with several spindles and uniform spooling flyers (c. 1490). Improvements in mass-production spinning machines were made in the eighteenth century, notably by James Hargreaves and Richard Arkwright, from which derive the mechanical procedures of modern spinning mills.

A. H. G.

**SPINOZA, BARUCH** or **BENEDICT DE** [spino'zə] (1632-1677), Dutch philosopher, was born Nov. 24, 1632, in Amsterdam. His parents were Jewish emigrants from the Iberian Peninsula, and he was brought up in the Orthodox Jewish religion. He was, however, excommunicated by the Jewish community in 1656 for his heretical views, and in 1660 he removed for some years to Rijnsburg, near Leiden, in association with members of the sect of Collegiants. From Rijnsburg he went to Voorburg near The Hague, and from 1670 till the time of his death on Feb. 21, 1677, he lived in The Hague itself. He made his living grinding and polishing lenses for the newly invented microscope and telescope, and in later years his income was supplemented by a small pension from two of his influential friends. This arrangement assured his independence and left him sufficient time to pursue his philosophical writing and correspondence with the leading scientists of his day. In 1673 he was offered the chair of philosophy at Heidelberg, but he refused it in view of the known hostility of the clergy to his views. His chief works are his *Tractatus Theologico-Politicus,* published anonymously in 1670, and his *Ethics,* completed in 1675, but published posthumously in 1677 in a Latin edition together with his unfinished treatises on scientific method, political theory, and Hebrew grammar.

Spinoza's contribution to the history of philosophical thought was determined, in part, by his position in time at the beginning of the modern era. It consists in his synthesis of Renaissance science with Greek, Stoic, Neo-platonic, and Scholastic philosophy. One reason for the difficulty scholars have found in interpreting his most famous work, the *Ethics,* is to be found in the fact that he frequently employs Scholastic terms in an entirely new sense. As a result, one must go behind his terminology and take his essentially modern, scientific, and ontological presuppositions into account in order to arrive at his real meaning.

Spinoza's basic interest may be regarded as philosophical anthropology, the study of man in relation to society and to the cosmos as a whole. The originality of his contribution lies in his attempt to extend the "Copernican revolution," initiated in astronomy, to the spheres of metaphysics, psychology, ethics, and politics. In other words, he attempted to view nature in general, and human nature in particular, objectively and scientifically, just as if he were dealing impersonally with a problem in geometry; he made a sustained effort to exclude, so far as possible, human wishful thinking such as is presupposed by the notion of ends or final causes in nature. Thus, in agreement with the Italian Renaissance philosopher Giordano Bruno, he was among the first to view the cosmos as infinite rather than as a finite system, and to accept the heliocentric hypothesis rather than the geocentric tradition of the Scholastics. He viewed man as part of the order of nature and not as a special creation exempt from its universal laws. God was conceived by him as the dynamic principle of order immanent within nature as a whole (*natura naturans*), as against the traditional notion of God as the transcendent creator of the order of nature. As the dynamic principle of order within nature, the God of Spinoza was essentially the impersonal God of the scientist, a God who may be conceived as the object of "intellectual love," but who, unlike the God of the Old Testament, did not reciprocate man's love and had no special concern with the welfare of individuals.

Building upon Descartes' dualistic theory of the relation of body and mind, Spinoza originated the theory of the parallelism of body and mind, the theory that the mind, like the body, is subject to determinate laws of activity. Spinoza thus provided the basis for the modern science of psychology. He considered the mind as a "spiritual automaton" subject to necessary laws of its own, just as the body was subject to the laws of motion, as Descartes had demonstrated. Furthermore, Spinoza, like Thomas Hobbes, was among the first of the Renaissance philosophers to apply Galileo's law of inertia to psychology and ethics, by postulating that by nature every form of life endeavors to persevere in existence indefinitely unless it is hindered from doing so by some superior force. The notion of the primacy of the endeavor (*conatus*) for self-preservation—later developed by Charles Darwin from an evolutionary, biological point of view—marked a complete departure from the theory of the Scholastic philosophers, who held that all forms of nature were directed to fixed ends or final causes and that human nature existed for the sake of some transcendent, supernatural end. In his *Ethics* Spinoza endeavored to construct a psychology of the emotions in which the emotions were considered as dynamic forces subject to determinate laws—laws that may be logically deduced from the nature of the three primary affects or emotions, namely, pleasure, pain, and desire. The notion that there is a logic of the emotions, and that the emotions are not merely irrational forces or diseases which have somehow to be suppressed or eliminated, is one that was scarcely appreciated in Spinoza's time. It is only in recent years, through the advent and recognition of Freudian psychiatry, that it is beginning to be recognized.

*BARUCH SPINOZA*

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In moral theory, Spinoza's originality was manifested by his transvaluation of traditional moral values—a fact which Friedrich Nietzsche later recognized—and by his interpretation of human virtue in terms of the efficient power of the individual. Spinoza's moral theory is naturalistic and of this world; it is opposed to the transcendental religious view that life on earth is but a preparation for life after death. Not grief and a sense of sin or guilt but joy and peace of mind are the leading motifs of his philosophy of life. Throughout his psychology and ethics the basic underlying theme is the humanistic one that human nature, as Francis Bacon said of nature as a whole, must first be understood and obeyed before it may be commanded and controlled.

In Spinoza's thought ethics and religion are blended. His philosophy of life is the classic attempt of modern times to construct a rational, universal system of human salvation which may dispense with supernatural sanctions and avoid any special appeal to historical revelations—an approach which has made it especially attractive to men of science like Albert Einstein, poets like Goethe and Wordsworth who sought communion with nature, and liberals generally who sought for some way of escaping the intolerance of dogmatic theology. D. B.

**SPINY ANTEATER.** *See* ECHIDNA.

**SPIRAEA** [spairi'ə], a genus of the rose family, of which about 75 species are native to the Northern Hemisphere, and about 12 to the United States. These plants are usually hardy shrubs, seldom more than 5 ft. high. They have rather small leaves, often lobed, and small white or pink flowers borne in conspicuous clusters. Those species having white flowers in flat clusters usually bloom from April to June; others, having white or pink flowers in spikes, usually bloom after June. Many are grown as ornamentals, including *S. thunbergii, S. Veitchii,* and the very popular *S. vanhouttei. See also* HARDHACK; MEADOWSWEET. J. C. Wis.

**SPIRES.** *See* SPEYER or SPIRES.

**SPIRITUALS,** in ecclesiastical history, the name given, probably by the common people, to several groups of Friars Minor of the late thirteenth and early fourteenth centuries. Opposed to necessary modifications in Franciscan life which were approved by the popes to enable the friars to settle in towns and attend universities, these groups sought authorized separation from the order on the plea that they wished to observe St. Francis' rule literally in its pristine severity. Three groups are to be distinguished. (1) The Spirituals of the Marches of Ancona (Italy), who separated from the Franciscan order about 1274, were excommunicated by John XXII in 1317. (2) The Spirituals of Provence (France), led by Peter John Olivi, certain of whose errors were condemned in 1312, were ordered by John XXII in 1317 to submit to Franciscan superiors. Twenty-five refused, of whom twenty-one were converted by the inquisitor, and four were burned as heretics at Marseilles in 1318. (3) The Spirituals of Tuscany, who separated in 1309, fled to Sicily and were excommunicated in 1318. *See also* FRATICELLI. W. C.

**SPIROCHETES** [spai'rokits] (Gr. σπεῖρα, coil, and χαίτη, hair), members of the order Spirochaetales, of the class Schizomycetes which consists of unicellular, frequently motile plants without a definite, organized nucleus. Spirochetes used to be regarded as Protozoa, but are now classified as Bacteria. They multiply by transverse fission and show no evidence of any sexual cycle. In mode of life, spirochetes may be free-living, commensal, pathogenic, or parasitic. The order includes two families, Spirochaetaceae and Treponemataceae.

**Nonpathogenic Spirochetes.** Members of the Spirochaetaceae family have cells with definite protoplasmic structure and are largely saprophytic or free-living, inhabiting water, sewage, and other organic wastes. Representatives of the true genus *Spirochaeta,* found in stagnant waters, are fairly long, ranging from 200 to 500 microns, and have a central axis, around which the body is wound. The protoplasm contains vacuoles and deep-staining granules. Members of the free-living genus *Saprospira,* found in fresh and salt waters and in oysters, are also fairly long, ranging up to 100 microns. They have rigid, undulating coils and lack crista, or ridges. Such ridges are characteristic of *Cristispira,* found in certain molluscs. *Cristispira* range from 45 to 100 microns in length, and are cylindrical, with short inner segments and coarse spirals.

**Pathogenic Spirochetes.** Most of the family Treponemataceae are parasitic, and many of them are pathogenic for man or animals. The family includes three genera: *Borrelia, Treponema,* and *Leptospira.*

*Borrelia* have the shape of delicate, spiral filaments, 10 to 20 microns long, with fairly regular coils. They can be cultivated in a laboratory and stain readily with aniline dyes but are best seen under a dark-field microscope. Some *Borrelia* species are saprophytic and apparently harmless. *B. vincentii,* together with some fusiform bacilli, is responsible for the ulcerative disease of the mouth, known as Vincent's angina. *B. recurrentis,* in Europe, and *B. duttoni,* in Africa, carried by lice and ticks, respectively, are the causative factors of relapsing fever.

By far the most dreaded genus of spirochetes is *Treponema,* a strictly anaerobic and parasitic form, difficult to stain and to culture. *T. pallidum* is the causative agent of syphilis. It is a delicate, spiral organism, 5 to 15 microns in length, highly flexible and motile. It is best seen under a dark-field microscope. *T. pertenue,* morphologically indistinguishable from *T. pallidum,* causes yaws. Some other *Treponema* species are pathogenic for man and animals; others, often present in the mouth, are apparently harmless.

The genus *Leptospira* is represented by small, slender organisms, 6 to 9 microns long, with fine, closely wound coils, often hooked at both ends. It is aerobic and can be grown in laboratory cultures. *L. icterohaemorrhagiae* is responsible for infectious jaundice. Diseases caused by this genus are localized primarily in the liver and kidneys. Other *Leptospira* species produce several varieties of febrile diseases in man and animals. *See also* RELAPSING FEVER; VENEREAL DISEASES; YAWS. B. Van R.

**SPITHEAD** [spɪ'thɛd'], a roadstead at the entrance to Portsmouth Harbor, Hampshire, England. It extends for 2 mi. in a north-south direction along the southwestern side of the Spit Sand, with an average width of one-half mile. S. Van V.

**SPITTELER, CARL** [shpɪ'tələr] (1845-1924), Swiss poet and novelist, was born April 24, 1845, at Liestal, Canton Basel-Land. At Basel he studied law, then theology, and continued his studies at Zürich and Heidelberg. A break with theological concepts forced him to become a teacher, first as a private tutor in Russia and Finland (1871-1879) and, upon returning to Switzerland, in schools at Bern and Neuenstadt. In 1885 he became literary editor of a Basel newspaper, and in 1890 of the *Neuen Züricher Zeitung.* An inheritance in 1892 enabled him to devote himself exclusively to his writings, and he moved to Luzern, where he lived until his death, Dec. 29, 1924.

Although primarily an epic poet, Spitteler is stylistically and spiritually related to the lyric Impressionists. The principal theme of his most significant works is the contrast between the superior man and the uncomprehending hostile masses. The superior man, the virile, aristocratic type, is represented by Prometheus in the prose epic, *Prometheus und Epimetheus* (1880-1881), a work strikingly akin, both in form and spirit, to Nietzsche's later *Also sprach Zarathustra* (1883-1885). In the great "cosmic" (i.e., transcending the human realm) epic, *Olympischer Frühling* ("Olym-

pian Spring"; 4 vol., 1900-1905), Hercules becomes the savior of mankind. The cosmic and heroic element also prevails in *Extramundana* (1882), a collection of short epics, and in the *Balladen* (1895). Shortly before his death Spitteler returned to his Prometheus theme, recasting his first work freely into rhyming hexameters: *Prometheus der Dulder* ("Prometheus the Long-Suffering," 1924). The contrast between the artist and the masses is shown in the psychoanalytic novel, *Imago* (1906).

In his prose narratives, *Die Mädchenfeinde* ("The Little Misogynists," 1891), *Conrad der Leutnant* ("Conrad the Lieutenant," 1898), and the autobiographical *Meine Frühesten Erlebnisse* ("My Earliest Experiences," 1914), Spitteler approaches the tradition of the realistic Swiss *Novelle*; and timely literary criticism is found in the collection of essays, *Lachende Wahrheiten* ("Laughing Truths," 1898). His best lyrics are found in the collections *Schmetterlinge* ("Butterflies," 1888) and *Glockenlieder* ("Bell Songs," 1906). In 1919, he was awarded the Nobel Prize for literature.

K.-H. P.

**SPITTLE INSECT,** a name given to both the nymphs and the adult members of the family Cercopidae, of the order Homoptera. The adults are also known as froghoppers, and in some parts of America the nymphs are called cuckoo spit insects. Eggs of the spittle insects are usually laid in the stems of grasses or on the bark of twigs. When the nymph hatches, it sucks the juices of the host plant and almost at once gives forth a frothy secretion, which increases in volume as the insect grows. Within this mass, which resembles the frothy saliva produced by man, the nymph is protected from its enemies, and grows to maturity. It then crawls from the spittle, and emerges as an adult hopping bug. Sometimes spittle insects are so numerous that grass and twigs are heavily spotted with their froth; they can cause serious damage to grasses and shrubs. They vary in size from ⅛ to ½ in. Most species, however, are about ¼ in. long. The sugarcane froghopper causes serious damage to sugar cane in Trinidad.

C. H. Cu.

**SPITZBERGEN.** *See* Svalbard.

**SPITZER, LEO** [shpɪ'tsər] (1887- ), Austrian linguist, was born in Vienna on Feb. 7, 1887. He began his teaching career at the University of Vienna in 1913, and after holding professorships at Bonn, Marburg, Cologne, and Istanbul, he went to the United States in 1936. As professor of linguistics at Johns Hopkins University at Baltimore, Md., he has trained a notable body of scholars.

A follower of Benedetto Croce and Karl Vossler, Spitzer is one of the foremost champions of the idealistic method in the study of language. Surpassing both Croce and Vossler in linguistic technique, he couples a daring vision with an enormous fund of knowledge and a scrupulous attention to details. His abiding interest lies in discovering the aesthetic motive that underlies linguistic expressions and changes, or, as he calls it, the "stylistic" of language.

Being essentially an individualist, Spitzer seeks the key to the understanding of language in the passing whims, fancies, and conceptions of the individual, and his first work deals with the language of an exceptionally fantastic and creative author, Rabelais (*Die Wortbildung als stilistisches Mittel, exemplifiziert an Rabelais,* 1910). He has also studied the styles of Henri Barbusse, Jules Romains, Charles Péguy, and Marcel Proust. Spitzer has done important work in phononology, morphology, and syntax, but the branch of linguistics that has attracted him most is etymology, which deals, especially in such manifestations as onomatopoeia and sound symbolism, with the impulsive, spontaneous creations of the individual.

Of the vast body of Spitzer's publications, the following may be mentioned: *Aufsätze zur romanischen Syntax und Stilistik* (1918), *Lexikalisches aus dem Katalanischen und den übrigen ibero-romanischen Sprachen* (1921), *Italienische Umgangssprache* (1922), *Stilstudien* (1928), *Classical and Christian Ideas of World Harmony* (1944), *Linguistics and Literary Semantics* (1948), and *A Method of Interpreting Literature* (1949).

G. B.

**SPLEEN,** an oval, flattened, glandlike organ, situated in the left upper part of the abdominal cavity. It is not essential to life and its congenital absence or surgical removal has no marked effect on normal life and growth.

**Anatomy.** The spleen is composed of several types of tissues. Embryologically, it is of mesodermal origin. Some of the primitive mesenchymal cells persist through life, while others develop into reticulo-endothelial and lymphoid cells. The splenic pulp consists largely of the former, while the lymphoid cells are found in the Malpighian corpuscles. The spleen is highly vascularized and is of a dull purple color. In addition to the serous peritoneal cover, it is covered by a capsule of dense, fibrous, elastic tissue, with bundles of involuntary muscles. Trabeculae pass from the capsule into the spleen, forming a framework for lobules. The spleen is the largest lymphoid organ in the body. It has direct connection with both the portal and the general circulations. It is still unsettled whether the spleen circulation is a closed or an open system.

**Physiology.** Galen regarded the spleen as an organ "full of mystery." Ancient Greeks and Romans reportedly removed the spleens of runners to increase their speed. The functions of the spleen are still incompletely known. For a long time, it was regarded as a ductless gland; since there is no apparent secretion, this view had been abandoned. Recently, the theory has been revived to some extent, attributing to the spleen a hormonal action that regulates the function of the bone marrow.

In early fetal life, the spleen has a hematopoietic function. By the ninth month, formation of red blood cells and of granulocytic white cells is taken over by the bone marrow, while the spleen from then on produces only lymphocytes and monocytes. In certain blood diseases, however, the spleen reverts to this embryonal function, and in some mammals it maintains this function throughout life.

In the human adult, the known functions of the spleen are threefold. As part of the reticulo-endothelial system, it has the important task of phagocytizing the worn-out red and white blood cells and blood platelets, as well as of breaking down hemoglobin into bilirubin and hemosiderin. The spleen is one of the richest iron reservoirs in the body. It also acts as a filter of bacteria, protozoa, and foreign particles. As a lymphoid organ, the spleen is the chief formative source of circulating lymphocytes, especially in youth and early adult life. As a circulatory organ, the spleen functions as a reservoir of red blood cells, from which they may be withdrawn in case of emergency. It is also possible that the spleen participates in the antibody formation, since splenectomized animals are more susceptible to infection.

**Disorders of the Spleen.** Primary diseases of the spleen are comparatively rare, but secondary involvement is more frequent than in any other organ.

*Abnormalities.* The spleen may be congenitally absent. Deviations in size, shape, and structure, such as excessive

lobulation, are also possible. Accessory spleens, sometimes in considerable numbers, are fairly common. Floating or wandering spleen occurs more frequently in women.

*Infarcts.* Infarction of the spleen vessels is fairly common. The infarcts are usually small.

*Torsion.* The pedicle of the spleen may become twisted, resulting in strangulation, and requiring surgery.

*Abscesses.* Abscesses of the spleen are sometimes caused by infarction and are also seen in enteric fever and in subacute bacterial endocarditis. They are usually chronic and painless and tend to heal spontaneously.

*Cysts.* The spleen is also subject to formation of dermoid and echinococcal cysts, which are extremely rare, and of serous cysts, which are more common. These, as well as rupture of the spleen, are usually the result of trauma.

*Degenerative and Neoplastic Diseases.* Amyloid degeneration, produced by chronic tuberculosis or chronic osteomyelitis, results in the so called "sago" spleen. Incidence of amyloid degeneration is becoming progressively lower. Atrophy of the spleen is common in old age and may also occur in sickle-cell anemia.

Primary malignant tumors of the spleen are rare; the typical neoplasm is lymphosarcoma. Metastatic involvement is somewhat more common.

*Splenomegaly.* Splenomegaly, or enlargement of the spleen, is the characteristic response of this organ to numerous systemic diseases. It may be associated with lymph-node enlargement, ascites, jaundice, leukopenia, fever, liver enlargement, and severe anemia. Splenomegaly is seen in many cardiovascular disorders; in such infectious diseases as malaria, typhoid fever, rheumatic fever, smallpox, measles, syphilis, meningitis, scarlet fever, etc.; and in blood dyscrasias such as leukemia, hemolytic jaundice, sickle-cell anemia, pernicious anemia, etc. In Hodgkin's disease, splenomegaly occurs occasionally, but in myelogenic leukemia the spleen becomes enormous. Metabolic disturbances, particularly of the lipid metabolism, are often accompanied by splenomegaly. Many diseases of the liver are reflected in the spleen. This is particularly pronounced in Banti's syndrome, in which cirrhosis of the liver is accompanied by splenomegaly and anemia. Gaucher's diseases, a familial malady, is manifested by inherited disorder of fat metabolism and marked splenomegaly.

Since splenomegaly is usually a reflection of some other disease, the treatment must be directed at the primary causative factor. Removal of the spleen is recommended only in certain conditions, such as hemolytic jaundice, thrombocytopenic purpura, or Banti's syndrome. B. Van R.

**SPLEENWORT,** a name for the large genus, *Asplenium,* of beautiful, mostly evergreen ferns of the true fern family. The several hundred species are found throughout the world. About 25 species are native in North America, mostly in the eastern and southern United States. Among the best known are three small ferns: the ebony spleenwort, *A. platyneuron,* having fronds 15 in. long; the maidenhair spleenwort, *A. trichomanes,* which makes tufts a few inches across in walls and cliffs; and the wall rue spleenwort, *A. ruta-muraria,* found in limestone cliffs, the fronds of which reach only 3 in. in length. Many tropical species are in cultivation, including the *A. nidus* of Asia. G. M. Sm.

**SPLIT** [spli't] (Ital. Spalato), the chief seaport of Yugoslavia, on the Dalmatian coast about 160 airline miles southeast of Rijeka (Fiume). Now a city in Bosnia-Hercegovina, Yugoslavia, Split was the capital of the former province of Dalmatia. It occupies a low peninsula on the rugged Dalmatian coast and is separated from the open Adriatic by numerous intervening islands.

Built in and around the palace, constructed by the Roman Emperor Diocletian in A.D. 305 for his declining years after abdicating, Split is near the ancient Greek town of Aspalathos. It was nearly destroyed by Avars in the seventh century of the Christian Era and subsequently came under the successive rules of Venice, Hungary, France, Austria, and Italy; it became Yugoslavian in 1918 and was occupied by Italians from 1941 to 1945, when it was freed by the Yugoslav army of liberation.

The old town (Stari Grad) of Split is a maze of dark, narrow streets within the walls of Diocletian's Palace, where hundreds of shops and thousands of people are crowded together in less than ten acres. The new town (Novi Grad) is modern, with wide streets, imposing buildings, and a beautiful park. The Roman palace and ruins of several castles, an imposing waterfront, and the picturesque homes and gardens of the suburbs, together with striking natural scenery and the fast-disappearing native costumes, combine to make Split a notably attractive city. It has rail connections with Rijeka as well as inland, and excellent port facilities normally handle exports of cement, lumber, bauxite, and cattle. Pop. 1948, 49,885. F. Sc.

**SPODUMENE** [spɒ'jumin], a lithium mineral usually classified in the pyroxene group. It is lithium aluminum silicate, $LiAlSi_2O_6$. The crystallization is monoclinic and prismatic; some crystals have been found up to forty feet in length. Spodumene is usually white or gray, and has perfect cleavage parallel to the prism faces and meeting at angles of 87° and 93°. A parting parallel to the front pinacoid may also be present. Spodumene turns the fusing flame red due to its lithium content. This mineral is mined as an ore of lithium in the Black Hills of South Dakota and in North Carolina. K. K. L.

**SPOHR, LUDWIG** [shpɔ'r] (1784-1859), German violinist, composer, and conductor, was born on Apr. 5, 1784, in Brunswick. He was a favorite among early German Romantic composers, but the great popularity enjoyed by his compositions during his lifetime was soon lost by all but the violin concertos. Spohr was a violinist and conductor of great ability. He was among the first to use a baton in conducting an orchestra, instead of the violin bow of the earlier concert masters. His works include operas, symphonies, violin concertos, oratorios, chamber music, and a violin method. Spohr died in Kassel, Oct. 22, 1859. E. L. F.

**SPOKANE.** *See* INDIAN TRIBES, NORTH AMERICAN (*Plateau*).

**SPOKANE** [spokæ'n], a city in eastern Washington, the county seat of Spokane Co. It is situated about halfway between the north and south borders of the state, 20 mi. west of the Idaho border, on the falls of the Spokane River, at an altitude of 1,981 ft., 30 mi. west of Coeur d'Alene, Idaho, and 115 mi. northeast of Walla Walla. Spokane is a distributing point for the surrounding fertile agricultural and stock-raising district. The city lies in the richest white-pine section of the United States; and lead, zinc, and silver also are natural resources of the region. Spokane is the financial and commercial center of the great western area known as the Inland Empire, which encompasses eastern Washington, western Montana and Idaho, northeastern Oregon, and

southern British Columbia. In 1810 the Northwest Fur Company established a settlement on the site, but it did not last. Spokane was founded about 1872 by James Glover. It was incorporated as a town in 1878 and as a city in 1881; the following year it was made the county seat. For some time it was known as Spokane Falls. The city is governed by a commission. Transportation is provided by the Great Northern, the Northern Pacific, the Union Pacific, the Spokane International, the Spokane, Portland and Seattle, and the Chicago, Milwaukee, St. Paul and Pacific railroads, and by the Northwest, the United, and the Empire air lines. The industrial output includes lumber and lumber products, aluminum, magnesium, cement and clay products, poultry, dairy and meat products, machinery and metal products, petroleum products, electrical fixtures, beer, paper, cereals, feed, and flour. Pop. 1950, 161,721.

**SPOLETO** [spole'to], an Italian city in Umbria, at the head of the valley of the Maroggia, on the Tessino River, a tributary of the upper Tevere (Tiber), 60 mi. northeast of Rome. Spoleto rests on the slopes of Monte Luco, at between 950 and 1,400 ft. above sea level.

Spoleto was a city of the Umbri before becoming an Etruscan center. It was taken by Rome in 241 B.C., during the Third Samnite War, and in 217 it repulsed Hannibal. After the fall of the Western Empire, the Goths, and later the Byzantines under Narses, took Spoleto. In the latter part of the sixth century the Lombards came down from the north and established the Duchy of Spoleto. Although this did not endure so long as the Lombard Duchy of Benevento, it preserved its autonomy until around 758, when it accepted the king of the Franks and the Pope as nominal overlords. Early in the thirteenth century the Holy See fully annexed the Spoletan territory, which formed part of the Papal States until 1860, when Umbria voted to join the Kingdom of Sardinia, later (1861) the Kingdom of Italy. During the late Middle Ages Spoleto was involved in the struggles between the Umbrian cities and between the Guelfs and the Ghibellines. More than once it rebelled against Papal rule, and in 1499 it was governed by Lucrezia Borgia.

Spoleto has a medieval appearance, with narrow, winding, and often steep streets, and a great number of Renaissance buildings. Several important remains attest to its importance in Roman times: a theatre, a triumphal arch dedicated to Drusus and Germanicus, a now subterranean bridge, and the house of Vespasian's mother, among others. Among the noteworthy churches are the Cathedral (consecrated in 1067 and containing frescoes by Filippo Lippi), Santi Giovanni e Paolo (with frescoes of the eleventh century), San Pietro (begun in the fifth century), and Il Crocifisso or San Salvatore (a basilica of the fourth century). Overlooking the town is the castle of La Rocca, constructed in the fourteenth century and completed by Pope Nicholas V in the middle of the fifteenth century. This was once used as the residence of the papal governors and more recently has served as a prison. The hill on which this castle stands is connected with Monte Luco by the Ponte delle Torri, with ten pointed arches, built in the seventh century.

The city experiences severe winters and has an annual precipitation averaging 44 in. Spoleto is now essentially a market and processing point for the agricultural products of the surrounding area. In the vicinity there are lignite mines. Spoleto is on the main railroad from Rome to Ancona. In 1926 a narrow-gauge electric line was opened from Spoleto to Norcia, 32 mi. east in the Apennines. Pop. 32,341 (including environs). R. G. W.

**SPONGE,** the common name for animals in the phylum *Porifera.* Sponges are characterized by their low grade of structure and their porosity. They form rounded, vaselike, or branched growths permeated with holes and permanently attached to rocks or other objects. They are unable to move, and have only slight powers of contraction, so that they seem to be more like plants, but their animal nature was established long ago. They vary in size from small crusts, or masses, to large balls or goblets that may reach a diameter of 3 ft. Sponges are usually of drab coloration, but orange, red, or yellow colors are not uncommon and blue, violet, and black sponges also occur. Although there are a few freshwater sponges, the vast majority are marine, generally inhabiting shallow waters, especially in tropical and subtropical zones. Some, however, are found in deep waters and one group, the glass sponges, typically inhabits ocean depths.

A sponge consists essentially of a mass of tissue permeated by water channels and supported by a skeleton. The tissue comprises an external flat epithelium, an interior mass of discontinuous cells of the nature of a mesenchyme or primitive connective tissue, and the channels of the water system, some parts of which consist of the chambers lined by the characteristic collar cells. The water enters by numerous small or microscopic pores strewn over the surface of the sponge, or sometimes aggregated into particular regions, and leaves by one or more large conspicuous openings termed oscula. The collar cell chambers occupy practically the entire interior of small sponges, but are reduced to clusters of small round cavities in larger types. A collar cell is a rounded cell having at its free end a transparent collar that surrounds the base of a long slender filament termed a flagellum. This flagellum keeps up an undulating movement, and the combined beating of all the flagella of the flagellated chambers causes a water current to flow through the sponge and out of the oscula. The presence of this current can be detected by adding colored particles to the water, whereupon a stream will be found flowing from the osculum with such force as to ascend considerably above the sponge. This water current is usually the only sign of life exhibited by a sponge. In a small sponge about 4 in. high, on which measurements were made, the rate of flow was found to be 3 to 4 in. per second, and it was estimated that the sponge passed about twenty-three quarts of water daily. The water current brings oxygen to the

*Sponges being sorted for market at Tarpon Springs, Florida, where warehousing and marketing are done on a co-operative basis.*

VICTOR DE PALMA FROM CUSHING

sponge, and also the minute organisms and particles on which it feeds. These food objects are caught and ingested by the collar cells, which are thus both the motor and the digestive part of the sponge.

One of the most characteristic features of sponges is the skeleton, which is imbedded in the mesenchyme and occurs in several types that furnish the basis for the division of sponges into classes. In the first class, Calcarea, or calcareous sponges, the skeleton consists of separate crystalline bodies composed of calcium carbonate. These bodies, or spicules, are either needle-shaped or three- or four-rayed. The calcareous sponges are mostly small sponges shaped like a vase and of bristly texture. They occur in shallow marine waters. The second class, Hexactinellida, or glass sponges, has a skeleton of silica consisting of six-rayed spicules, some of which are usually bound together to form a lattice. The Venus'-flower-basket is an example of a glass sponge. Glass sponges generally inhabit the ocean depths, so that they are obtained only by dredging. Little is known of their life habits. They are commonly fastened to bottom muck by a root tuft of siliceous filaments resembling glass wool. The third class of sponges, Demospongiae, includes the siliceous and horny sponges; to this group belongs the vast majority of sponges including the fresh-water forms and the bath sponges. The skeleton of this type of sponge consists of siliceous spicules of varied form (but not the six-rayed form), or of a network of horny fibers, known as sponging, or of a combination of both. The skeleton of sponges is secreted by certain cells of the mesenchyme.

Sponges have no nervous system and therefore show little response to external changes. They do, however, possess muscle cells, especially around the larger openings of the water system, and these will contract slowly on direct stimulation, or in response to unfavorable conditions.

Sponges reproduce both asexually and sexually. They have extensive powers of regeneration, and any small bit can grow in time into a complete sponge. Sponges can even be dissociated into cells, or cell masses, by pressing them through fine cloth, and these masses will come together and regenerate into a sponge. Sponges, especially the fresh-water ones, also reproduce asexually by forming round reproductive bodies termed gemmules. These bodies consist of a mass of cells enclosed in a protective surface. The gemmules are commonly formed in autumn, and tide the fresh-water sponges over winter. They hatch in spring into tiny sponges that soon grow to adult size. All sponges also reproduce sexually. Eggs and sperm are formed by certain of their cells, and resemble those of other animals. Sponges are usually hermaphroditic; that is, eggs and sperm are produced in the same animal, although not always simultaneously. The egg is fertilized while still in the sponge body, and develops there into a flagellated larva that swims about for a time, and then settles on a suitable object, where it grows.

The fresh-water sponges form a family, the Spongillidae, which belongs to the group of siliceous sponges obviously derived from marine ancestors. They occur as small growths, green or brown in color, on twigs, plant stems, boards, and other such objects found in lakes, ponds, and streams in temperate regions. They characteristically produce gemmules in the fall, after which they generally disintegrate.

The bath sponges belong to the horny sponges, which have a skeleton consisting of a network of material allied to horn. They form rounded or slightly lobulate dark-colored masses in shallow warm waters on rocky bottoms. The best localities for them are the Mediterranean, the Gulf of Mexico, and the West Indian-Caribbean region. They are taken by means of hooks on the end of long poles, or by skin or suit divers. The live part of the sponge is eliminated by various means, as treading or threshing, followed by maceration in shallow water. Finally nothing is left but the horny network, which constitutes the commercial sponge and owes its water-absorbing powers to the capillary attraction of its meshes.

L. H. Hy.

**SPONGE CRAB,** a small or medium-sized crab of the family Dromiidae which commonly fashions a closely fitting portable shelter of living sponge. The two last pairs of legs in these crabs are shorter than the others and bent upward over the back to assist in holding the sponge in place. With considerable ingenuity, the crab cuts out the sponge fragment from a living sponge and trims it to the correct shape with its pincers. As the sponge continues to grow, it forms a progressively larger shelter to conceal the growing crab.

F. A. C.

**SPONTANEOUS COMBUSTION.** *See* Oxygen.

**SPOONBILL,** any one of several species of large, long-legged wading birds in the genera *Platalea* and *Ajaia,* closely allied to the ibises. They inhabit temperate and tropical regions throughout most of the world. They are characterized by having the long bill flattened and greatly expanded near the tip in the shape of a spoon; their plumage is mainly white, but the roseate spoonbill, *Ajaia ajaja,* a 32-in. bird of the New World, is carmine and pink. Spoonbills are found in flocks, frequenting shores both on coasts and in the interior, and nest in colonies on low trees. They feed on small aquatic animals, such as fishes, amphibians, and crustaceans, which they obtain by immersing the bill and swinging it from side to side. The American species was formerly common in the Gulf states, but is now restricted to a few localities in Florida and Texas. H. G. De.

**SPORE PLANTS,** a name applied to the three great classes of the vegetable kingdom: (1) the Thallophyta, or thallus-like plants which include the fungi and the algae; (2) the Bryophyta, or moss-like plants; and (3) the Pteridophyta, or fern-like plants. All of these are flowerless, or cryptogamous, plants in which reproduction takes place by means of spores instead of by seeds, as in the flowering plants. *See also* Bryophyta; Pteridophyta; Thallophyta. F. J. S.

**SPOROPHYTE.** *See* Bryophyta (*Alternation of Generation*); Ferns; Reproduction, Plant.

**SPOROTRICHOSIS.** *See* Mycoses.

**SPOROZOA** [spo′rozo′ə], a class of Protozoa which form spores and are parasites in animals. Organelles of locomotion are usually absent. Sporozoites, the infective stage of the parasites, are introduced into a new host either by ingestion or by bloodsucking organisms. The three subclasses are Telosporidia, Acnidosporidia, and Cnidosporidia. The Telosporidia include the Gregarinida, Coccidia, and Haemosporidia. The gregarines are parasites of the body cavity of annelids, earthworms; and arthropods, insects; and crustaceans. The coccidians invade the lining of the digestive tract causing an inflammatory disease called coccidiosis in chickens, cattle, and other animals. Besides the malarial parasites, the blood-inhabiting haemosporidians include *Babesia* the causative agent of the tick transmitting piroplasmosis of man, cattle (Texas cattle fever), sheep, pigs, horses, and dogs. *Toxoplasma* is another haemosporidian infecting mammals. It is the cause of a degenerative disease of the brain (encephal-

opathy) in rabbits and chronic toxoplasmosis in reptiles, birds, and mammals. The Acnidosporidia include the Sarcosporidia and Haplosporidia. The Sarcosporidia (*Sarcocystis*) are found in the body and heart muscles of mammals, including man. The parasites elaborate a lethal poison, sarcocystin. Recent studies indicate that this parasite may be a fungus. The haplosporidians infect invertebrates and fishes, in the latter inducing massive unsightly sores. The Cnidosporidia include the Myxosporidia, Actinomyxidia, Microsporidia, and Helicosporidia. They are parasites of invertebrates and aquatic vertebrates. Those affecting fishes are of economic significance since they are responsible for the loss of thousands of pounds of important food fishes. *Nosema bombycis* is a microsporidian that causes the silkworm disease, pébrine, first investigated by Pasteur.

R. F. N.

**SPORTING ARMS,** a term applied to firearms, including guns, rifles, shotguns, pistols, and revolvers, intended or used primarily for such sporting purposes as hunting, target shooting, competition, or recreation.

**Rifles.** The invention and use of gunpowder to propel missiles from fixed tubes, probably dates from the thirteenth century. However, the application of this principle to sports was not practicable until after the invention of an ignition system that made it possible to carry guns ready for firing at all times, without a burning fuse to frighten away game.

The first of the flint and steel locks, the wheel lock, was invented during the first quarter of the sixteenth century, and thereafter sporting weapons designed primarily for various forms of hunting began to appear. Although by the late seventeenth century a workable flintlock had been developed, this and all of the early models had the common drawback of the necessity for a pan of powder on the side of the barrel and an open hole through the barrel into the main charge, which was usually loaded down the muzzle. Runs of 18 out of 25 at skeet have shown, however, that these old guns, despite many deficiencies, were not as clumsy as popularly supposed.

Most of the guns for sporting use were loaded with a single ball. Those designed for hunting during the sixteenth and seventeenth centuries were smooth bore and were distinguished from military muskets principally by their lightness and ornamentation, as well as by the superior workmanship of their locks and metal parts.

The earliest of the true rifles also existed during this period, however, and the rifled barrel was known before the wheel-lock era, particularly in Central Europe, where the short, heavy, large-bore wheel-lock rifle, or harquebus, was a fairly common hunting weapon during the seventeenth century. However, at this time, the principal drawback of the European rifles was the common use of a bare ball the size of the bore which had to be hammered down into the barrel against the resistance of the lands of the rifling, thus making a fouled gun almost impossible to load and a clean one the work of some ten or fifteen minutes. The ball, by the time it reached the charge and was fired, was so misshapen that it was sometimes relatively little more accurate than a smooth-bore musket. However, the rifle was in fairly common use during this period, and its principles were brought to America in the early and middle eighteenth century by Central European gunsmiths.

*Kentucky Rifle.* The most typical American hunting piece, although in many cases in the eighteenth century "hunting" was classed as obtaining the necessities of life rather than as a sport, was the so-called Kentucky rifle. This was an excellent example of evolutionary principles in design, since every feature was adapted to backwoods and frontier conditions. The Kentucky rifle was, and is, a long-barreled graceful flintlock arm of relatively small bore (.40 to .50 caliber), with its sights set low on the barrel. It was designed to be used with a patched ball, which was the secret of its surprising accuracy. The ball, instead of being hammered down the bore, was wrapped in a patch of greased linen or buckskin and, being smaller than bore diameter, was rammed smoothly home with an easy stroke of a wooden ramrod.

Target accuracy comparing favorably with that of modern arms was obtained with the Kentucky rifle up to at least 100 yd., and man- or large-game-killing accuracy was possible up to two or three times that distance. Five consecutive shots touching a silver dollar at 100 yd., or striking within a six-inch circle at 250 yd. are not uncommon examples of Kentucky rifle shooting. Most of these rifles were made in Pennsylvania but were largely used by the backwoodsmen who travelled into Kentucky, hence their name of Kentucky rifles. They formed the pattern for a class of sporting rifles of a later date.

*Plains Rifle.* The "plains rifle" was typical of the early to middle nineteenth century. Linked with this was development of the percussion cap, the ancestor of the modern primer, which was the result of the application of a detonating powder (fulminate of mercury) to the discharge of firearms by Alexander Forsyth, a Scottish clergyman, in 1807. The method of filling a copper cap with a small quantity of powder and placing it on a pierced nipple at the breech of the firearm, to be struck by the hammer, was probably the invention of Joshua Shaw, of Philadelphia, in about 1816. Percussion cap sporting arms were common by 1825 but were not adopted for military purposes until the middle or late 1840's. The primer of modern cartridges is simply a percussion cap with its own anvil, contained in the head of the cartridge case. The plains rifle, for the most part, adopted the new percussion cap system of ignition soon after it came into general use. This piece had the graceful shape of the Kentucky rifle, but was shorter and heavier for use on horseback and usually of somewhat larger bore. These were the guns with which the buffalo were slain and with which the plainsmen and mountain men defended themselves from the plains Indians.

*Heavy Target Rifles.* Heavy target and sporting rifles began to appear in the 1840's and reached the height of their development shortly before the Civil War. These took advantage of the phenomenal accuracy of the conical or "sugar loaf" bullet. They were relatively short but of barrel weights from 10 to 30 lb. and were loaded by means of an elaborate false muzzle and bullet starter to seat conical bullets in muzzle-loading weapons, invented by Alvan Clark around 1840.

These were the popular target rifles of the target shoots preceding the Civil War and the weapons carried by the best of the sharpshooters during the war. Target shooting with these heavy-barreled rifles was commonly done in a manner called "rest" shooting, in which the pieces were rested on a bench or log and fired for maximum accuracy over known ranges at a mark which was primarily an aiming point. The competition was designed to produce the smallest possible group. Target matches of this sort were very popular from the 1850's through the 1870's, and bets of from $500 to $1,000 were fairly common.

*Repeating Rifle.* Inventive genius during the middle of the nineteenth century also began to produce the real boon to sportsmen, the repeating rifle. The oldest action of this type had its beginnings in the work of Hunt and Jennings in the late 1840's. Self-exploding metallic cartridges, that

is, cartridges having their own primers as well as powder and ball, were first developed during the 1850's. Those with priming in their rims, called rim-fire, were the first type, and various center-fire cartridges appeared in the 1860's. By about 1870, the general form was a brass or copper case with a pocket in its head for a separate primer, a charge of black powder filling the case completely, and a grooved and lubricated or patched lead bullet crimped into the mouth of the case to form a complete unit.

Further improvements in the Winchester design produced in 1873 a center-fire arm using the famous .44 Winchester center-fire cartridge. This was the saddle gun of the old West, and many shooters still cling to modern versions of the old lever-action design. It shared with the heavy single-shot rifle, epitomized by such extinct weapons as the Sharps, the Maynard, and others, the combined functions of hunting and Indian warfare.

This black-powder period gave rise to a series of weapons utilizing bullets which, for the most part, were from .40 to .50 caliber, had weights from 200 to 500 grains, and developed velocities from 1,100 to 1,600 ft. per second. The most powerful of these arms were accurate up to 1,000 yds.; they killed more game than probably will ever again be killed in the United States. Buffalo were commonly shot up to ranges of 400 to 500 yds.

*English Double Rifle.* European sporting rifles in the nineteenth century, and particularly English rifles, soon began to reflect the characteristics required by the increased use of sporting arms by Englishmen in India and Africa. Double-barreled sporting rifles, while not common in the United States, have been popular in England since the first encounters by Englishmen with large game in the Indian and African colonies. These rifles had the same general appearance as double-barreled shotguns, with side-by-side barrels, but were heavier than the average shotgun.

*Smokeless Powder.* A change in military arms was brought about by the development of satisfactory smokeless powder by the French engineer Paul Marie Eugéne Vieille, in 1886. This new powder, with its greatly superior power and almost complete lack of barrel fouling, made possible the small-bore, metal-jacketed-bullet, military-type cartridge with muzzle velocities between 2,000 and 2,500 ft. per second and a range two or three times that of the heavier, slower, black-powder bullet. The military rifle at that period used the turning bolt action rather than the lever or slide action to perform its repeating function. The original bolt-action, single-shot "needle" gun of Johann Nikolaus von Dreyse of the 1840's was improved by Paul von Mauser and Ferdinand Ritter von Mannlicher during the 1870's and 1880's. The modern box magazine, situated below the bolt and receiver, holding its cartridges in a single or staggered vertical column parallel to the bore rather than one behind the other in a tube below the barrel, was invented in 1879 by an American, James Paris Lee. These elements of repeating arms, appearing first in military weapons, gradually became more and more common in sporting arms of the 1890's and early 1900's although they were not popular in the United States.

*Semiautomatic Rifles.* The semiautomatic or selfloading action was adapted to sporting rifles in about 1905 by both Winchester and Remington. This principle consists of making a repeating arm by utilizing some of the gas or recoil of the explosion of the cartridge to perform the following functions: throw out the empty shell; build up pressure in a spring designed to close the breech and chamber a fresh cartridge from the magazine; and cock the piece, so that it is ready to fire again with another pull of the trigger. This has been accomplished in many types of weapons by a number of different systems, but the necessity for a separate pull of the trigger for each shot makes all of these semiautomatic weapons distinct from the full automatic arm, which continues to fire until the magazine is empty. Semiautomatic sporting rifles have never closely rivaled either the bolt- or lever-action systems in popularity.

*Modern Bolt-Action Rifles.* During World War I some four million American civilians were introduced to the uses of the bolt-action military rifle and its numerous advantages. This had the effect of changing preference in sporting rifles in the postwar period from lever-action to bolt-action types. The leading arms companies brought out bolt action repeating rifles and chambered them for newer and more powerful cartridges designed after the United States military cartridge caliber .30 Model 1906. These cartridges ranged from the standard .30'06, with its 150- to 220-grain bullet and velocities from 2,200 to 2,800 ft. per second, to the high-powered .22 center-fire cartridges, including the .220 Swift, with its 50-odd-grain bullet and velocity of 4,000 ft. per second. After further recent developments, the average modern telescope-sighted, bolt-action sporting rifle driving a killing bullet has an accurate and practical range of well over 500 yd. on reasonably well-known distances, and will shoot into a 20-in. circle at 1,000 yd. known range.

Prior to World War II, European sporting rifles built on the Mauser bolt-action were made in calibers up to .500 in standard box magazine design for heavy game hunting in Europe and Africa, and the English-type double rifles made both in England and Central Europe were still, even with modernized smokeless-powder, metal-jacketed ammunition, the standard weapons for heavy and dangerous game.

**Shotguns.** In the adaptation of firearms to hunting, it became obvious that a number of small pellets in a load, collectively called shot, was more apt to hit a bird than a single ball, so that the shotgun or "fowling" piece was developed as a distinct weapon early in the wheel-lock period, beginning the first quarter of the sixteenth century. In a reversal of modern practice, however, the wheel-lock shotgun was of smaller bore than the average rifle or military arm of the same period and also relatively lighter. Wheel-lock shotguns with a bore as small as .32 caliber in diameter are found in the larger arms collections.

*Early Gun Performance.* With the smooth-bore arm, the common weapon of the period, it was possible to use any musket or gun for shooting birds, simply by loading it with a charge of shot of appropriate size rather than a single ball. During the seventeenth and early eighteenth centuries the transition from wheel lock to the later flintlock occurred in the shotgun as well as in other types of arms, and the shotgun at this time developed into an extremely long, single-barreled weapon having a total length in many cases of over six feet, still commonly of fairly small bore. Since they were too long and ponderous for wing-type shooting, these guns were not used extensively for shooting birds in the air, but were primarily intended for shooting individual birds, either stationary or running along the ground.

*Shotgun Improvements.* At about this time, also, the trend toward the modern-type shotgun began. Better locks, placed on relatively short, double-barreled weapons, gave the shooter a chance to hit a bird in the air with fair regularity. The greatest of the English gunsmiths, and the man referred to as the father of the modern shotgun, was Joseph Manton of London (1766-1835). His influence was felt in shotgun design before 1800, and by the time he died the standard

shotgun had attained approximately its modern form of a double-barreled, half-stocked weapon of smooth lines and excellent balance. The percussion cap was applied to the shotgun and greatly speeded the action and improved the functioning of the gun. There the shotgun ceased to improve until the application of various early breech-loading systems in the 1850's and 1860's, making the arm more convenient to handle but not greatly superior in point of range or accuracy.

Finally, in about 1869, the choke bore added what was to become the greatest improvement in shotgun design. This development, giving control of patterns for close shooting, resulted more or less accidentally from experiments by Fred Kimble, a gunner in the middle western United States, who bored his gun with the hole slightly smaller at the muzzle.

The modern double-barreled shotgun, except for its superior smokeless powder load, is not greatly improved over the earlier choke bores either in range or accuracy, since no way has been found to drive the light individual shot pellets much farther than they could be driven a hundred years ago.

*Repeating Actions.* Repeating actions have been more commonly adapted to shotguns in the United States than in England or Europe. The lever action of the American Winchester was first applied in 1887; the more common slide action appeared in the 1890's and has been manufactured since. The auto-loading system, in this instance as commonly applied to shotguns, is a long-recoil action. It uses the kick of the gun to move the barrel and breechblock back about three inches and compress the springs for returning both of them to firing position. This extracts the empty shell and loads a fresh one from the magazine. It was developed by John Browning shortly after 1900, and was applied first in the United States by the Remington Co. in 1905 and later by other makers after Browning's patent expired.

**Pistols.** The earliest known pistols were heavy and relatively clumsy and, while they were used and carried extensively by "the gentry and nobility," were not commonly used for sporting weapons, except as a defense auxiliary to other arms in hunting dangerous game. The early lock improvements of the seventeenth century and early eighteenth century were passed on to the pistol, while general improvement in shape and lightness made it a practical arm for reasonably accurate shooting up to 15 or 20 yds. The eighteenth century introduced the use of the pistol for dueling.

Pistol practice for accuracy and some target shooting appeared in the late eighteenth century, but it remained for the introduction of the rifled French dueling pistol of the nineteenth century, first in the flintlock and later in the percussion cap type, to provide a weapon sufficiently accurate for serious target shooting. Particularly in Paris, shooting galleries became common and popular. Among the best known was that of Gaston Renette, which continued for many years.

*Development of Revolvers.* The application of a repeating system to the handgun was the work of Samuel Colt, who in 1836 patented a "many-chambered rotating breech pistol" and in the next fifteen years brought the design into common use.

Revolving pistols or "revolvers" in percussion cap and later cartridge designs were the common weapons of the 1850's and 1860's. In a recorded match in 1860 between Capt. John Travers, of Missouri, and another man, each contestant fired one shot at each of 15 china plates, all 9 in. in diameter and 100 ft. away. Captain Travers, breaking 11 of 15 plates, won the match. Hunting with the pistol, which had become a breech-loader using metallic ammunition, was fairly common on the Western plains, where hunters and cowboys carried revolvers in their belts and such experts as Buffalo Bill Cody and W. P. Shafe were noted for their buffalo shooting with pistols as well as rifles. While perhaps a large part of the pistol play of the old West did not come under the head of "sporting" activities, the single action Army Colt, also known as the Colt's "Frontier" or "Peacemaker," played a prominent part in the winning of the West. *See also* Explosives; Firearms; Hunting and Trapping; Target Shooting. C. T. H.

**SPORTS.** The term "sports," as used in this article, refers to "athletic sports," a term that covers a wider range of physical activities in the United States than it does in most other countries, where it is generally applicable to only track and field sports.

**Athletics in the United States.** Athletic sports in the United States include approximately one hundred sport activities in which men, women, and children participate either as individuals, as groups, or as teams. These activities include highly publicized, thoroughly organized amateur and professional sports such as baseball, football, basketball, tennis, golf, hockey, and track and field. Many of these are thought of, for the most part, as "spectator" sports, in which a comparatively small group of participants plays before large numbers of spectators. Athletic sports also include dozens of less-publicized sports, such as bowling, handball, horseshoes, shuffleboard, and softball, in which the participants engage principally for their own recreation and amusement. Baseball, football, basketball, and the other spectator sports, are also engaged in solely for the players' own enjoyment.

That spectator sports have a firm hold on the interest of sports-minded Americans was convincingly shown in the years immediately following World War II. Crowds attending sporting events in that period were of record proportions. Major league baseball attendance reached a record 20,972,601 in 1948. Horse racing was watched by record crowds everywhere, and college and professional basketball drew great numbers of people to gymnasiums and indoor arenas such as Madison Square Garden in New York and the Boston Garden. Professional golf tournaments attracted huge crowds, and important tennis matches were played before crowded grandstands. The University of Michigan football team frequently played before more than 90,000 people. Other sports that continually attract thousands of spectators include hockey, track and field, polo, and boxing. A gathering of 104,943 persons, the largest crowd ever to see a boxing match, watched the Jack Dempsey-Gene Tunney fight in Chicago in 1927. Spectators also gather in considerable numbers to see high-school football, baseball, and basketball games. The lesser-known college teams throughout the country play to sizable local audiences. Even small-town or industrial softball leagues attract sizable crowds to their games.

Telecasts of sporting events make it possible for even more American people to watch sports. Americans also follow sports events through the means of radio broadcasting and newspaper reports. The first sporting event broadcast over the radio was the Dempsey-Willard fight in 1919.

Despite this sedentary practice of watching others engage in sporting events, most Americans of all ages participate in athletic games of one sort or another. Many sports facilities

are offered and practically all of the larger communities in the United States have playgrounds. Most elementary, high, and secondary schools have gymnasiums, athletic fields, and, in many cases, swimming pools. Colleges and universities have facilities for the practice of athletic sports of every kind. Private athletic clubs in the larger cities have swimming pools, gymnasiums, handball courts, squash courts, and athletic fields. Many private clubs, devoted to one sport, provide their membership with the facilities needed for that sport. Public and private golf courses dot the country, public and private swimming clubs are available for swimming and bathing, and states and cities maintain bathing beaches and parks for residents.

According to the National Recreation Association, founded in 1906 as the Playground Association of America, the following facilities for community recreation were available in 1950 (including school facilities open to the community):

| | |
|---|---|
| Outdoor playgrounds | 14,747 |
| Recreation buildings | 2,987 |
| Indoor recreation centers | 6,633 |
| Archery ranges | 573 |
| Athletic fields | 1,933 |
| Baseball diamonds | 5,502 |
| Bathing beaches | 780 |
| Bowling greens | 220 |
| Golf courses | 454 |
| Handball courts (outdoor) | 1,953 |
| Horseshoe courts | 11,013 |
| Ice-skating areas | 3,274 |
| Shuffleboard courts (outdoor) | 4,791 |
| Ski jumps | 104 |
| Softball diamonds | 12,266 |
| Stadiums | 504 |
| Swimming pools (indoor and outdoor) | 1,616 |
| Tennis courts | 13,085 |
| Toboggan slides | 268 |

**Amateur Athletic Organizations.** In many sports, particularly football, basketball, track and field, tennis, and golf, amateur athletics retain a special dignity and prominence in the United States. The strength of amateur athletics stems from the powerful organizations that protect, guide, and rule over nonprofessional sports. The first of these organizations was the National Association of Amateur Athletes of America, which was formed in 1879 in New York City and existed for nine years. However, it was not able to control or direct the athletic sports program satisfactorily. During its existence the situation became deplorable, and the leaders in the field of athletic sports decided to form a new organization to protect and foster amateurism in American athletics. As a result, the Amateur Athletic Union (A.A.U.) of the United States was established in the New York Athletic Club on Jan. 21, 1888. The purpose of the A.A.U., as stated at the time of its organization, "shall be the improvement in, and the encouragement of, athletic sports among amateurs and the fostering and promotion of the interests of its members." It has become the most powerful organization of its kind in the world, and has played an important part in the promotion of athletic sports in the United States. It has also helped foreign amateur athletic organizations through goodwill tours, the loan of coaches, and assistance in setting up constitutions and by-laws. The A.A.U. is allied with the International Amateur Athletic Federation, and has been a decided aid to that important governing body of sports. The A.A.U. claims jurisdiction over the following sports: basketball, bobsledding, boxing, codeball, gymnastics, handball, horseshoe pitching, ice hockey, swimming, tobogganing, track and field, tug of war, volleyball, water polo, and wrestling.

The colleges of the United States have retained a separate sports identity. The Intercollegiate Association of Amateur Athletes of America was organized in 1875. Fourteen colleges were represented at the initial meeting—Amherst, Bowdoin, Brown, College of the City of New York, Columbia, Cornell, Dartmouth, Harvard, Princeton, Trinity, Union, Wesleyan, Williams, and Yale—all colleges from the eastern seaboard. Many more colleges, mostly from the east, have since joined the association. The I.C.A.A.A.A., or IC4A, has been conducting outdoor track and field meets since 1876, and since 1922 a series of indoor meets.

The National Collegiate Athletic Association was founded in December 1905 in New York City, at which time the existence of intercollegiate football was threatened because of the number of serious and even fatal injuries to players. As the result of a meeting of university presidents and college representatives, the rules of football were changed to give more protection to the players. A constitution was adopted and through it, the N.C.A.A. sought to control the rules of football, to establish better standards for the conduct of intercollegiate sports, and to serve as a clearing house for the exchange of ideas relating to student participation in athletic sports. The N.C.A.A. rules committee frames and publishes rules for football, soccer, track and field, lacrosse, swimming, wrestling, and ice hockey. It also assists the National Basketball Committee in formulating the rules for basketball. Championships are held annually in track and field, swimming, boxing, wrestling, cross country, gymnastics, basketball, golf, fencing, and tennis. The N.C.A.A. serves more than three hundred member colleges in all parts of the United States.

The National Federation of State High School Athletic Associations was founded in 1920 in Chicago, Ill. It serves as an aid to state high school associations in forty states by formulating plans and policies for improving high school athletic conditions. Over eighteen thousand schools are reported to be members of the N.F.S.H.S.A.A.

Many individual sports, such as archery, baseball, basketball, golf, softball, tennis, volleyball, and others, have separate controlling organizations which look after the interest of their members. Prominent among these are: the National Archery Association, the United States Lawn Tennis Association, the United States Golf Association, and the Amateur Softball Association. *See also individual sports.*

L. C. S.

**SPOTSYLVANIA, BATTLE OF** [spɒ'tsɪlve'niə] (May 8-18, 1864), in the Civil War, a series of engagements below the Rapidan River in Virginia. After the Battle of the Wilderness, General Ulysses S. Grant, instead of withdrawing toward Washington, as each of his predecessors in the eastern theatre of the war had done after a losing battle, moved his army around General Robert E. Lee's right flank toward Richmond. Divining his enemy's purpose, Lee moved General James Longstreet's corps, commanded by General R. H. Anderson, to Spotsylvania Courthouse, on the road from Fredericksburg to Richmond. The fighting began May 8, when General Anderson's division attacked the advance Federal troops under General G. K. Warren. Soon both armies were engaged all along the line. Both sides entrenched, and desperate fighting at the "Bloody Angle" did not succeed in changing the tide of battle. The Federal army, awaiting reinforcements, did not avail itself of its advantages. On May 11, while both armies rested, Grant wrote his famous dispatch to General H. W. Halleck: "I propose to fight it out on this line if it takes all summer." The next day Generals W. S. Hancock and A. E. Burnside led assaults which penetrated

the Confederate line and forced Lee to take up new entrenchments. On the night of May 20 Grant moved again around Lee's right flank in the direction of the North Anna River. The Federal casualties in these engagements were about 20,000; Lee's losses were over 12,000. Lee, however, could not replace his men, while Grant had ample reinforcements. W. B. H.

**SPOTTED CAT.** *See* Ocelot.
**SPOTTED FEVER.** *See* Rickettsia.
**SPRAIN, TREATMENT OF.** *See* First Aid.

**SPRAT,** *Clupea sprattus,* a small commercially important herring, of the family Clupeidae. They are found in salt water along the north coast of Europe south to the Mediterranean. Sprats are similar to the herring, *Clupea harengus,* but with the dorsal fin inserted farther back and with strong spines edging the sharply-keeled belly. Sprat eggs are buoyant in contrast to the demersal egg of the herring. Spawning occurs in coastal waters from January until midsummer. The young, called brit, are very abundant in schools along shore and are greedily eaten by mackerel and other predacous species. Sprats may reach a length of 5 to 6 in. as adults. The young sprats mixed with those of the herring are often sold as whitebait. In Norway, many are canned as sardines. E. C. R.

**SPREADHEAD.** *See* Hog-Nosed Snake.
**SPRING.** *See* Seasons.

**SPRING,** a flow or seep of ground water escaping at the earth's surface. The term "spring" implies a flow of water, but "seeps" have the same origin and may be springs during wet seasons.

Most spring water is completely or principally atmospheric or meteoric water that has soaked into the ground from rain or melting snow. Other sources are from magmas which have crystallized to form igneous rock (juvenile water), or the water deposited with sediments (connate water). This supply of ground water is contained in the various openings, pores, and fissures in the rocks near the earth's surface. A zone of water-saturated rock occurs close to the surface in most parts of the world. The upper surface of this saturated zone is called the water table. Wherever the water table intersects the surface of the earth there will be springs or seeps. Since the depth to the water table varies from season to season and year to year depending upon rainfall, springs may change to seeps or dry up completely, or seeps may become springs. The water table intersects the earth's surface at the level of all permanent streams and lakes; seeps or springs furnish much of the supply for these bodies of water.

**Hillside Springs.** In a region of hills and valleys, some of the water which soaks in near the hilltops may reappear below as springs in the valleys above the level of the streams. This will result if there is sufficient water to keep the level of the water table above the level of the streams. In areas where some of the rocks are permeable, so that water can move through them easily, and other rocks are impervious, so that water moves through them with difficulty if at all, springs may occur where the water in its downward movement is checked by the impervious layers and is forced to move sideward and escape where the permeable layers crop out at the earth's surface. Hillside springs are usually small and of variable flow. They frequently go dry between rainy seasons.

**Artesian Springs.** A porous, permeable layer overlaid by an impervious layer may crop out at a number of places on the earth's surface. Water soaking into such a layer at the higher outcrops may reappear under pressure at the lower outcrops, thus forming an artesian spring. ("Artesian" is derived from *Artesium,* the Roman form of Artois, a region in northeastern France in which springs and wells of this type are common.) Some of these water-bearing layers (aquifers) may be of large extent, and consequently the artesian springs issuing from them may be large and of fairly uniform flow. Some famous oases in North Africa are the result of such artesian springs. In some fault springs, artesian water rises along a fault from a buried aquifer.

**Limestone Springs.** Some of the largest springs in the world occur where water issues from cavernous limestone. The carbon dioxide contained in most water that soaks in at the surface of the earth renders it capable of dissolving limestone, and consequently most limestone regions contain channels and caves formed by solution. In such regions, underground rivers are not uncommon and very large springs may occur. The Vaucluse spring in southern France, perhaps the largest in the world, has a maximum flow of about thirty thousand gallons per minute. The water issues from a limestone opening, and the spring drains a region of cavernous limestone. Silver Springs in Florida, another limestone spring, has an average flow of about five thousand gallons per minute.

**Springs from Porous Lava.** Large springs may occur where water issues from porous fractured lava beds. Along the Snake River below Shoshone Falls, Idaho, there is a series of large springs that contribute considerably to the size of the river. These springs issue from porous lavas of the Snake River lava plateau.

**Hot Springs.** Most hot springs occur in volcanic areas. The water is for the most part ordinary ground water that has been heated by the rocks which occur close to the surface near volcanoes, though a small amount may be of magmatic origin. At some hot springs the temperature of the water may be the result of the water having risen from a considerable depth, since the temperature of the rocks increases by about 1° F. for every 60 ft. of depth. Thus water that has risen from a considerable depth in artesian springs may be quite warm. Probably this explanation accounts for the warm water at Warm Springs, Va.

**Mineral Springs.** At mineral springs the water contains dissolved material in noticeable amounts. This mineral material has usually been dissolved by the water as it has passed from the surface through the rocks and back to the surface again. Warm or hot springs are the most likely to contain noticeable amounts of dissolved minerals.

**Geysers.** Geysers are erupting hot springs peculiar to volcanic areas. *See also* Geyser. J. T. W.

**SPRING,** a mechanical element of slender form that can take a large elastic deflection under load and come back to free or original form when the load is removed or relaxed. It conforms more or less exactly to Hooke's Law that deflection is proportional to load. Springs are commonly made of hardened steel with a high limit of elasticity, but in light springs other metals such as bronze and hard brass are used. The pneumatic tire acts like a spring, but is called an elastic cushion. Typical forms of spring include the plate, leaf or beam-type (wagon spring), the spiral coil (clock spring) and the helical coil. In the first two, the principal stress effect due to load is bending; in the last it is torsion.

COURTESY OF THE AMERICAN MUSEUM OF NATURAL HISTORY

*SPRINGBOK*

**Functions and Uses.** One function of the spring is to store energy. The archer's bow with instantaneous release, the oldest elastic device, is an illustration, as is the clock spring with slow and controlled release. The function of a multitude of small springs is to hold, let move, and return. Such action occurs in door locks and electric snap switches. A lock of warded-key type has a spring for its latch and one for each tumbler on the bolt. A cylinder lock has a tiny spring under each of its five little plungers. Springs are widely used on wheeled vehicles; interposed between running gear and body of vehicle, they modulate the jolts caused by irregularities of road or track. Quick movement by the wheel is first absorbed by the spring; then the unbalanced portion of the spring force imparts a slower movement to the body. The body tends to go into an oscillation, which is damped by friction (especially between the leaves of a plate spring) and in many vehicles by some form of shock absorber.

Springs are used to measure force with moderate accuracy. The spring balance, the traction dynamometer, and instruments for measuring pressure are used for this purpose. In the usual pressure gauge, a closed-end bent tube responds to variation of internal pressure, changing its curvature slightly as pressure varies. The engine indicator, with spring above small piston, measures and records rapidly varying pressures. Springs may impose determinate controlling force. This is the case in the safety valve for steam boiler and other pressure vessels. In governors for engines and turbines, spring force is balanced against centrifugal force to determine speed of running.

Some springs, such as the hairspring or balance-wheel spring of a watch or portable clock, promote continuous motion. So does the stiff helical spring that helps to actuate a valve on a combustion engine, pushing against cam action.

R. C. H. H.

**SPRING BEAUTY,** a genus, *Claytonia,* of the purslane family, having about 25 species, chiefly native to North America. They are low, spreading perennial herbs with narrow, succulent leaves and loose clusters of white or pink flowers which appear in early spring. The Virginia spring beauty, *C. virginica,* is an attractive wild flower of the eastern seaboard, and has narrower leaves than the Carolina spring beauty, *C. caroliniana,* which has the same range. The lance-leaf spring beauty, *C. lanceolata,* native from Utah west, has darker pink flowers.

J. C. Wis.

**SPRINGBOK** [sprĭ′ŋbŏk], a South African antelope *(Antidorcas marsupialis),* so called from its method of reacting to a sudden fright. Several stiff-legged bounds eight or ten feet high may so startle an enemy that the first attack fails, permitting the springbok to use its great speed and so escape. This antelope is reddish brown and has a white face and underparts. About thirty inches high at the shoulders, it weighs seventy to eighty pounds. Both sexes of the springbok have lyre-shaped horns which are fourteen to seventeen inches tall.

V. H. C.

**SPRINGER SPANIEL.** *See* Dog.

**SPRINGFIELD,** the capital city of Illinois and the county seat of Sangamon Co., situated in the central part of the state, on the Sangamon River, 165 mi. southwest of Chicago. It is historically famous as the home and the burial place of Abraham Lincoln. Springfield was settled in 1818 by a pioneer family who had moved there from South Carolina; trappers and hunters from Virginia and Kentucky drifted there during the next few years, and in 1825 the settlement became a county seat. It was incorporated as a city in 1840, having previously been chosen the capital of Illinois in 1837, primarily through the efforts of the then young lawyer of the community and member of the Illinois Legislature, Abraham Lincoln, and several of his associates. Springfield lies in a rich agricultural region yielding excellent crops of corn and other grains; livestock raising and dairying also are important. It is the center of the coal-mining industry of Sangamon Co., and has well diversified manufacturing industries, which include foundries, machine shops, and factories that produce farm implements, woolen textiles, soap, and leather. Springfield has shown a steady growth in population from the time of its inception. The city has the commission form of government.

Springfield is noted for its fine buildings and parks. The state capitol, arranged in the form of a Greek cross and surmounted by a huge dome, is one of the most impressive among the state capitols. The old State House, which dates from 1837 and has many historical associations with Lincoln's career in Illinois, is now the Sangamon County Courthouse. Among the other buildings on the capitol grounds are the Supreme Court Building; the Illinois State Armory; the State Archives Building; and the Centennial Building, which houses the State Museum, the Illinois General and Historical libraries, and various administrative departments. The outstanding tourist attraction, however, is the Lincoln Tomb and Monument, one mile north of the capitol, where the remains of the Great Emancipator, his wife, three of his sons, and a grandson rest within a crypt surmounted by a 100-ft. obelisk. The Lincoln Monument, designed by Larkin Goldsmith Mead, is situated in Oak Ridge Cemetery. The Abraham Lincoln home in Springfield, like the monument, is owned by the state and maintained as an historical shrine.

Springfield is the seat of Concordia Theological Seminary and Springfield Junior College. Transportation is provided by the Gulf, Mobile and Ohio, the Illinois Terminal, the Springfield Terminal, the Wabash, the Baltimore & Ohio, the Illinois Central, and the Chicago & Illinois Midland railroads. Pop. 1950, 81,628.

G. Q.

**SPRINGFIELD,** a city in the southwestern section of Massachusetts, the county seat of Hampden Co., situated on the Connecticut River, 92 mi. southwest of Boston and 3 mi. north of the Connecticut border. It is the third largest city

in the state and is noted as the home of the Springfield rifle and the Garand semi-automatic.

**History.** The first settlement of the community was made on the west side of the river in the spring of 1636 by a group led by William Pynchon. The fear of clashes with the neighboring Indians caused the settlers to move to the less fertile east side of the river on the present site of Springfield. In 1640 the settlement's name was changed from Agawam to Springfield, commemorating Pynchon's English birthplace. Springfield was incorporated as a town in 1641, and Pynchon was undisputed leader of the community until 1652 when he departed for England after being publicly condemned and deprived of his magistracy by the Massachusetts General Court for his heretic writings. During King Philip's War in 1675 the Agawam Indians, who had been friendly until then, destroyed much of the community in a surprise attack. At the outset of the Revolutionary War Springfield had numerous gunsmith shops, which were transformed into small factories supplying arms to Colonial forces, thus starting the industry for which Springfield is famous. In 1777 the town's small arsenal was enlarged, and Springfield became an important supply point for the Continental Army. In 1786 followers of Daniel Shays made an abortive attack on the arsenal to secure arms for Shays's "army." It was the official establishment by Congress of a Federal armory at Springfield in 1794 that determined the town's growth as an industrial community. This brought about an increasing supply of skilled workers in the town, which, in turn, attracted numerous industries because of the availability of such a labor force. Industrial development was further stimulated by the opening of a railroad between Worcester and Springfield in 1839, and in 1852 Springfield became a city. On Apr. 19, 1892, Charles E. Duryea conducted what many authorities considered the first real test of a gasoline-driven vehicle in the United States, and in September 1895 Duryea organized the first United States motor corporation, which became inactive three years later. A mayor and a board of aldermen and city council administer the local government.

**Transportation and Industry.** Air transportation is available at near-by Westfield with daily flights provided by the American, the Eastern, the Northeast, and the United air lines. The New York Central, the New York, New Haven and Hartford, and the Boston and Maine railroads furnish freight and passenger facilities. The manufacture of arms continues to be important in Springfield. The diversified factory output also includes automobile accessories, tools, electrical machinery, paper products, textiles and clothing, toys, sporting goods, castings and forgings, refrigerators, matches, air-conditioning and heating equipment, and rubber products. Publishing is also a leading industry. Pop. 1950, 162,399.

S. D. M.

**SPRINGFIELD,** a city in southwestern Missouri, the county seat of Greene Co., situated about 150 mi. southeast of Kansas City, in an agricultural area where dairying and poultry raising are important. The city is a shipping center for the products of the adjacent territory, which has large timber resources. Founded about 1830, Springfield was made the county seat in 1833, and it was incorporated as a town in 1838 and as a city in 1846. The city government is the commission type. Occupying a strategic position during the Civil War, Springfield changed hands several times before 1862 when it was seized permanently by Federal forces with which "Wild Bill" Hickok served as scout and spy. The Battle of Wilson Creek was fought near by. National and Confederate cemeteries are in the near vicinity, as is Sequiota State Park. The city is the seat of Drury College, Southwest Missouri State Teachers College, and a government hospital for the criminally insane. Transportation is afforded by the Missouri Pacific and the St. Louis-San Francisco railroads, and by the American Airlines. There are large railroad shops in the city. Local manufactures include flour, refrigerator equipment, trucks and trailers, cement, lime, stationery, clothing, and dairy products. Pop. 1950, 66,731.

**SPRINGFIELD,** an industrial city in west central Ohio, the county seat of Clark Co., situated at the confluence of Lagonda Creek and the Mad River, 23 mi. northeast of Dayton. In 1799 James Demint built a cabin overlooking Lagonda Creek on the townsite. In 1801 he planned the town. The settlement prospered despite threatened Indian trouble, which was terminated through a council in 1807 with Indian Chief Tecumseh. Springfield was incorporated as a town in 1827 and in 1850 secured a city charter. A commission and city manager administer the community. Springfield is the seat of Wittenberg College and the state homes of the Masons, the Knights of Pythias, and the Odd Fellows. Transportation is supplied by the Pennsylvania, the Erie, the New York Central, and the Detroit, Toledo and Ironton railroads. Springfield is in a fertile farming district where corn, wheat, oats, hay, and potatoes are the principal crops, and in the city there are large commercial rose nurseries. Publishing is a major industry in the city, the Crowell-Collier Publishing Company alone shipping over 200,000,000 magazines a year. The diversified industrial output includes farm implements, incubators, electric motors and equipment, trucks, automobile parts, castings, and furnace stokers. Pop. 1950, 78,508.

**SPRINGFIELD,** a town in north central Tennessee, the county seat of Robertson Co., situated 24 mi. north of Nashville, in an agricultural area where corn, wheat, and tobacco are leading crops. Hardwood timber and building stone are natural resources of the region. Springfield is the commercial center of the county, and an important shipping point for the surrounding territory. It is also a prominent loose-leaf tobacco market. Springfield has the commission type of government. Transportation is afforded by the Louisville & Nashville Railroad. The output of local industries includes tobacco products, lumber, blankets, and flour. Pop. 1950, 6,506.

**SPRINGFIELD,** a town and village in southeastern Vermont, situated in Windsor Co., on the Black River, near its confluence with the Connecticut River, about 67 mi. south of Montpelier. The surrounding large agricultural area is marked chiefly by poultry and dairy farms. Springfield was founded about 1772. The government of the town is the council-manager type. A natural feature near by is the Falls Bridge, towering high above the chasm into which the Black River avalanches. Springfield is renowned for its machine-tool manufacture. Manufactures of the town include gear-shapers, lathes, grinders, machinery, and reworked wool. Pop. 1950, 9,190.

**SPRINGFIELD COLLEGE,** an accredited, privately controlled professional school combining general education and preparation for professional leadership in youth-serving agencies. While the college is primarily for men, women are admitted to the upper level for graduate and part-time courses. The college occupies a 230-acre campus in Springfield, Mass. It was founded in 1885 as a School for Christian Workers, with a two-year professional course. The name

was changed to the International Young Men's Christian Association Training School in 1890, and to the International Young Men's Christian Association College (still its corporate name) in 1910. It is popularly known as Springfield College. The regular four-year course was established in 1916 and the graduate division leading to the masters' degrees in education and in physical education in 1926. The college is now organized with six professional majors.

Degrees offered are the B.S. and the M.Ed. in group work and community organization, guidance and personnel services, health and physical education, social science and teacher education, recreation and camping. The library contains collections of books on physical education and Y.M.C.A. history. Graduate fellowships and undergraduate scholarships are available to applicants who qualify. Foreign students are eligible for scholarship aid and they are given priority in the assignment of dormitory rooms. Residence halls are available for male students. *For statistics see* COLLEGES AND UNIVERSITIES. J. R. To.

**SPRINGHILL,** a town in Cumberland Co., Nova Scotia, Canada, 128 mi. northwest of Halifax, located on Provincial Highways 2 and 4. First settled by United Empire Loyalists, it became populous after the discovery of coal in 1834, and it was incorporated as a town in 1889. Three mines employed 1,250 men in 1947 and produced approximately 500,000 tons of coal. Pop. 1951, 7,138. D. F. P.

**SPRING HILL COLLEGE,** a college of liberal arts and sciences for men, controlled by the Jesuit Fathers of the Catholic Church. The institution is located in Spring Hill, Ala., a residential suburb of Mobile. It was founded and first instruction was given in 1830. Six years later the charter was granted by the legislature of Alabama. The A.B. and the B.S. are offered in liberal arts and the B.C.S. in business administration. Dormitories and dining halls are provided. Students from outside the city are required to live in the college residences. The national fraternities on the campus do not maintain houses for their members. Scholarship aid is limited. *For statistics see* COLLEGES AND UNIVERSITIES. J. R. To.

**SPRINGS,** a town in the Union of South Africa, 30 mi. east of Johannesburg in the southern Transvaal, and one of the oldest settlements in the Witwatersrand (Rand). It is the center of a rich gold and coal region, and its eleven gold mines produce a quarter of the total output of theWitwatersrand. Next to the mining output, the most important products are paper, pulp, brass, iron, timber, mining materials, building bricks, milled maize, plumbing supplies, and fertilizers. Agriculture in the region is well developed. The city is situated at an altitude of 5,925 ft. above sea level. Pop. 1951, 119,392. W. S. V.

**SPRINGTAIL,** the common name given to insects of the order Collembola. They are all minute (usually less than 1/10 in.) wingless insects having an incomplete metamorphosis. Most of them possess a long posterior process of the abdomen that enables them to leap into the air. Springtails often occur in enormous numbers, frequently becoming pests in moist cellars and water pipe channels. They feed chiefly on decaying matter and fungi, but the aquatic species feed on tiny animals and plants. The snow flea, *Achorutes nivicolus,* occurs on snow; the seashore springtails, *Anurida maritima,* and, *Xenylla maritima,* occur in abundance along the seashore in summer; the water springtail, *Podura aquatica,* is usually abundant along the edges of pools and ponds in summer, and many hundreds may be present on each square foot. The garden springtail feeds on plants and is often injurious. In Europe and Australia, the Lucerne flea, a bright green species, is a pest of clover. More than 1,100 kinds have been described, but little is known about their biology. C. H. Cu.

**SPRING VALLEY,** a city in northern Illinois, situated in Bureau Co., on the Illinois River, about 100 mi. southwest of Chicago. The region has extensive coal mines, sand and gravel pits, and asbestos deposits. The district's farmers grow corn, wheat, oats, and soybeans. Founded in 1876 by the Spring Valley Coal Company, the community was incorporated as a city in 1886. From December 1888 to November 1889 Spring Valley was the scene of a strike by the local coal miners. The city has the alderman form of government. John Mitchell, labor leader, made his home in Spring Valley for a number of years. Transportation is furnished by the Chicago and North Western, the Chicago, Rock Island and Pacific, and the Chicago, Burlington & Quincy railroads. Coal mining continues to be an important occupation of the city's and district's residents. The local industries produce automatic controls, iron castings, concrete blocks, neon signs, and clothing. Pop. 1950, 4,916.

**SPRINGVILLE,** a city in central Utah, situated in Utah Co., 50 mi. southeast of Salt Lake City. The city lies at the base of the Wasatch Mountains, 4 mi. east of Utah Lake. The community is the shipping center for the region's cattle, poultry, eggs, peaches, cherries, and sugar beets. Founded in 1850 by Mormon pioneers, it was incorporated as a city in 1853. Springville has the mayor-council form of government. The art collection owned by the high school and the Springville Art Gallery are local features. The gallery is the site of an annual national art exhibit. Springville was the birthplace of Cyrus E. Dallin, sculptor, and George Sutherland, Supreme Court Justice. The largest state game farm and fish hatchery in Utah as well as a Federal fish hatchery is located in Springville. Transportation is furnished by the Denver & Rio Grande Western and the Union Pacific railroads. The region's limestone is used by Springville's steel industry. The local plants include planing mills, hatcheries, a creosote factory, and a cannery. Pop. 1950 6,475.

**SPRINTING.** *See* TRACK AND FIELD SPORTS.

**SPRUANCE, RAYMOND AMES** [spru′ənz] (1886- ), American naval officer, was born in Baltimore, Md., on July 3, 1886. He was graduated from the United States Naval Academy in 1907, and was promoted through the various grades to the rank of rear admiral in December 1939. He was assistant chief of staff to the commander of the naval forces in Europe, 1924-1925, and was chief of staff and aide to the commander of a destroyer scouting force, 1933-1935. After acting as commander of the Tenth Naval District, San Juan, Puerto Rico in 1940-1941, he returned to the office of the Chief of Naval Operations at Washington and, at the outbreak of war with Japan in December 1941, he was sent to the Pacific theatre of operations. In 1942, in the Battle of Midway, Spruance administered a decisive defeat to a large Japanese naval force, and after a period as chief of staff to Admiral Chester W. Nimitz, in November 1943 he was placed in complete charge of operations during the landings of the United States Marines on the Gilbert Islands of Makin and Tarawa. He also served as

chief of the newly created Central Pacific command. He was in command of the invasion of the Marshall Islands on Jan. 30-31, 1944, and of the naval action against Truk in the Carolines on Feb. 16-17. He had tactical command of the task-force operations against the Marianas on February 22 and against Palau, Yap, Utithi, and Woleai on March 29-30. Spruance was appointed admiral in February 1944, and in April was designated commander of the United States Fifth Fleet and was placed in command of the amphibious invasion of Iwo Jima and Okinawa. On June 18-19 his Fifth Fleet won a decisive victory over a large Japanese fleet in the waters between the Marianas and the Philippines. On November 8, Admiral Spruance was named deputy commander in chief of the Pacific Fleet and, on Nov. 20, 1944, was appointed commander in chief, succeeding Fleet Admiral Chester W. Nimitz. On Dec. 28, 1945, Admiral Spruance became head of the Naval War College. He retired from the Navy on July 1, 1948, and the following January was promoted to permanent four-star rank. In January 1952 he was named United States ambassador to the Philippines.

E. B. A.

**SPRUCE,** a common name for *Picea,* a genus of evergreen trees of the pine family. The coniferous trees are of pyramidal shape and are native to the cooler parts of the Northern Hemisphere. They have whorled branches, narrow, needlelike leaves, and pendant cones found on the upper branches. The drooping cones distinguish the spruce from the firs which bear upright cones.

Seven species of spruce are native to North America, and three of these occur in the eastern United States. They are medium-sized trees, growing to a height of 100 ft. and a diameter of 3 ft. White spruce, *P. glauca,* and black spruce, *P. mariana,* are found from Labrador to the coast of Alaska and in the Great Lakes region, the former also in northern New England and the latter in New England, New York, and south, in the Appalachian Mountains, to North Carolina. Red spruce, *P. rubens,* grows from New Brunswick south through the Adirondack region and in the mountains to Georgia. In the Rocky Mountain region, there are two spruces, the Englemann spruce, *P. engelmannii,* a valuable timber tree sometimes growing 150 ft. high, and the much less plentiful Colorado or blue spruce, *P. pungens,* of similar size. The latter has a characteristic bluish-green foliage, varieties of which, including the Koster blue spruce, are popular ornamentals. The Pacific Coast spruces include the Sitka or tideland spruce, *P. sitchensis,* found along the coast from Cook Inlet, Alaska, to northern California, and also the rare Brewers, or weeping spruce, *P. breweriana,* a comparatively small tree which grows only in the coastal mountains of northern California and southern Oregon. The Sitka spruce, which often grows 200 ft. high and has a diameter measuring 8 to 10 ft. above the buttressed base, is the largest of the spruces. It yields lumber of excellent quality.

The Old World species include the Norway spruce, *P. abies,* tiger's-tail spruce, *P. polita,* and the Alcock spruce, *P. bicolor,* both native to Japan; the oriental spruce, *P. orientalis,* a native of western Asia; the Serbian spruce, *P. omorika*; and the Himalayan spruce, *P. smithiana.*

Spruce wood has a uniform texture and is moderately light in weight. It is unusually high in strength and stiffness considering its weight. Sitka spruce is obtainable in clear, straight-grained pieces of large size, and was used extensively in World Wars I and II for airplane construction. Spruce is especially suited for the manufacture of paper; the quantity of eastern spruce converted into paper pulp is equivalent to about five times that sawed into lumber. Spruce lumber is used principally for shipping boxes, light building construction, and interior finish millwork.

W. D. B.

CHARLES PHELPS CUSHING

COLORADO SPRUCE, PICEA PUNGENS

**SPURGE,** common name for a plant belonging to the large spurge family, *Euphorbiaceae.* The name is applied particularly to *Euphorbia,* a genus of milky-juiced herbs, shrubs, and trees. Spurges also include the genus *Pachysandra,* low growing, perennial herbs or subshrubs of the box family, native to eastern Asia and eastern North America. They are used as ground covers. The American spurge or spurred gentian, *Halenia deflexa,* is a shrub of the gentian family. *See also* CROWN OF THORNS; POINSETTIA.

J. C. Wis.

**SPURGE NETTLE,** a low, shrubby perennial, *Cnidoscolus stimulosus,* of the spurge family having stinging hairs on the leaves. It grows in sandy soil in the southeastern United States. This attractive, harmless-looking plant has heart-shaped leaves and large, fragrant, white flowers. It is also aptly called the tread-softly.

J. C. Wis.

**SPURGEON, CHARLES HADDON** [spɜ′rjən] (1834-1892), English Baptist minister and one of the most distinguished preachers of the nineteenth century, was born in Kelvedon, Essex, June 19, 1834. Beginning to preach at the age of sixteen, he was soon the sensation of London, and by 1856 his success in attracting congregations was so great that his church in Southwark was enlarged and renamed Spurgeon's Church. This also proved too small, and the Metropolitan Tabernacle was opened for him in 1861; here Spurgeon ministered until his death in Menton, France, Jan. 31, 1892. He wrote fifty volumes of sermons collected as *The Tabernacle Pulpit, Treasury of David* in seven volumes, *John Ploughman's Talks* (1869), *The Gospel of the King* (1893), *The Soul Winner* (1895), and his *Autobiography* (1898-1899).

P. H. A.

**SPURS, BATTLE OF THE.** *See* COURTRAI, BATTLE OF.

**SPY: A TALE OF THE NEUTRAL GROUND, THE,** the first successful novel by James Fenimore Cooper, based on a legend of the American Revolution told him by his neighbor John Jay, and first published in 1822. Harvey Birch, a peddler who traveled between battle lines, is suspected of being an English spy, though he is secretly in the employ of General Washington. The "neutral ground" of Westchester County, New York, houses rebel and loyalist alike, and much of the complicated plot deals with problems of the Wharton family and its divided allegiance. Young Henry Wharton is really an English spy, but his sister Frances sympathizes with the patriots. Capture and exciting escape, with Birch everywhere playing the role of deliverer, is the pattern of the book, interspersed, however, with strikingly realistic scenes of rebel marauders and camp followers, which are among the best that Cooper ever wrote. L. L.

**SPYRI, JOHANNA** [shpi'ri] (1827-1901), Swiss author of books for children, was born July 12, 1827, at Hirzel, Canton Zürich. The child of a cultured mother, who had local fame as a poetess, and of a country physician with a wide practice, she also enjoyed the stimulating variety of a large and busy household. Her many books, children's classics everywhere, thus record much of her own richly happy childhood in her native mountain environment. *Heidi,* her most renowned book, which was several years in preparation, appeared in 1880 and continues to attract children of all countries by its perennial freshness.

Johanna Spyri was one of the first Swiss women to become widely known, though her creative ability lay dormant until she was past fifty. Her unsophisticated stories depict the generalized Swiss child; they display a great love of nature, a deep understanding of the child mind, and a democratic approach. They attempt to inculcate simple piety and moral lessons. Each of her works originally carried the subtitle "Stories for children and for those who love children." She died in Zürich, July 7, 1901. L. Ba.

**SQUAB.** *See* PIGEON.
**SQUARE.** *See* GEOMETRY.
**SQUARE, MAGIC** *See* MAGIC SQUARE.

**SQUASH,** the fleshy fruit of several species of *Cucurbita* of the gourd family. The squash is believed to be native to America. The plants are tendril-bearing, often long-running annuals, closely allied to the pumpkin. The Hubbard, turban, Boston marrow, and other winter varieties are forms of *C. maxima;* the cushaw, Canada, and winter crookneck squashes, *C. moschata,* include varieties called sweet potato, Quaker pie, and Japanese pie pumpkins; summer squashes or bush pumpkins, *C. pepo melopepo,* have varieties such as pattypan, scallop, summer crookneck, and cocozelle squashes. They vary greatly in form and color. Squash, like pumpkin and cucumber, bears male and female flowers, requiring insects to bring about pollination. Weather conditions which prevent insect flight may mean a poor commercial crop.
V. A. T.

**SQUASH BUG,** the common name of *Anasa tristis* a member of the family Coreidae. Both adults and young suck the plant juices of squashes, pumpkins, gourds, and other cucurbits; often they kill the plant. The eggs are laid singly or in clusters of as many as forty on the stems or the undersides of the leaves. Adults and nymphs are usually found together, and because they spend most of their time on the underside of leaves, they may do considerable damage before their presence is detected. C. H. Cu.

**SQUASH RACQUETS,** also called squash, a game played with a 27-in. round-headed racket and a 1¾-in. black pneumatic rubber ball in an enclosed rectangular court. It probably originated at Harrow, England, before 1850 and reached the United States shortly after 1900, appearing almost simultaneously in Boston and Philadelphia. The twentieth century brought a steady expansion of the game until it became well established in schools, colleges, and clubs in England, northeastern and midwestern United States, and Canada, with club and private courts scattered over the world.

**Development.** The evolution of the game differed in England and the United States. In England, a slower ball and a higher tell-tale, or metal strip at the base of the front wall, which, when hit, put the ball out of play, made it difficult to "kill" the ball and encouraged stamina and steadiness. In America, a faster ball and a lower tell-tale offered greater opportunities for winning placements, while a narrower court aided the retriever in reaching them. English scoring makes it possible for many points to be completed with no change in the score, thus again favoring endurance, as contrasted with the American rule, which scores every point. In about 1937, considerable friendly correspondence between nations seemed to indicate that the American game was a slight favorite as to ball, scoring, and tell-tale, although many preferred the wider English court.

The popularity and rapid growth of the game can be attributed to several factors: it is inexpensive once courts are installed; it offers quick exercise to men, women, and children of all ages; it is fun for the inexperienced and a real challenge to a skilled athlete. Accomplished players customarily employ sliced and chopped strokes, using very little arm motion but considerable wrist snap. The most common shots are the drive, the volley, hard and lob services, the lob, and the corner shot, which strikes the sidewall first near the front wall, and the drop shot, a very soft shot that rebounds as little as possible from the front wall. The essentials for unusual success are a quick mind, a quick wrist, and quick feet.

Annual competitions in America and England include interclub leagues, intercity and international meets, and national, state, city, intercollegiate, and local titles of all sorts for both individuals and teams, men and women, with some doubles where courts are available.

**American Rules.** A match is begun by spinning a racket to decide who shall serve the first point. Thereafter, throughout the match, the winner of each point serves the following point. The server may always begin serving from either side, but must alternate if he serves more than one point in succession. A second service is permitted if the first is a fault. The server must place one foot within the service box, since to step on the line is a foot fault. His service must first strike the front wall, above the service line. The first bounce or contact of the ball with the floor must be within the other service court: a player stands in the box in one court and serves into the other. In traveling from the front wall to the service court, the ball may or may not strike the side walls or back wall.

The receiver may stand wherever he chooses, barring interference with his opponent's service stroke. The orthodox position is on the line separating the two service courts. He may allow the ball to bounce or take it on the fly (volley). If he plays it on the fly, the service is presumed good, provided it was good on the front wall. The receiver's shot and

all subsequent shots by both players must be played on the first bounce or on the fly, and must reach the front wall above the tell-tale, directly or via the walls, without first striking the floor or ceiling. The ceiling and tell-tale are at all times out of court. The floor is out of court until after the ball has struck the front wall. The side and back walls are out of court for a service until after the service has struck the front wall. The point continues until one player strikes the ball out of court or fails to strike it before the second bounce. Service lines, courts, and boxes have no significance after the service has put the ball in play.

**Squash Racquets Doubles.** The doubles court, standard in England and America, measures 45 by 25 ft.; it is 20 ft. high on front wall and on side walls for a distance of 31 ft. from front wall, thereafter 15 ft. high. Other dimensions are: back wall, 7 ft. high; service court, line 15 ft. from back wall; service line, 8 ft. 2 in. from floor; service box, a quarter circle 9 ft. 6 in. in radius; tell-tale, 17 in. high. The ball is regulation size but is more lively than the singles ball. The racket is the same. The rules of play and scoring duplicate those in singles, except for service. The order of service goes through the two members of each team in succession. As in singles, the service moves only when the server loses a point. Thus, in doubles, the receiving team must win two points to regain the service.

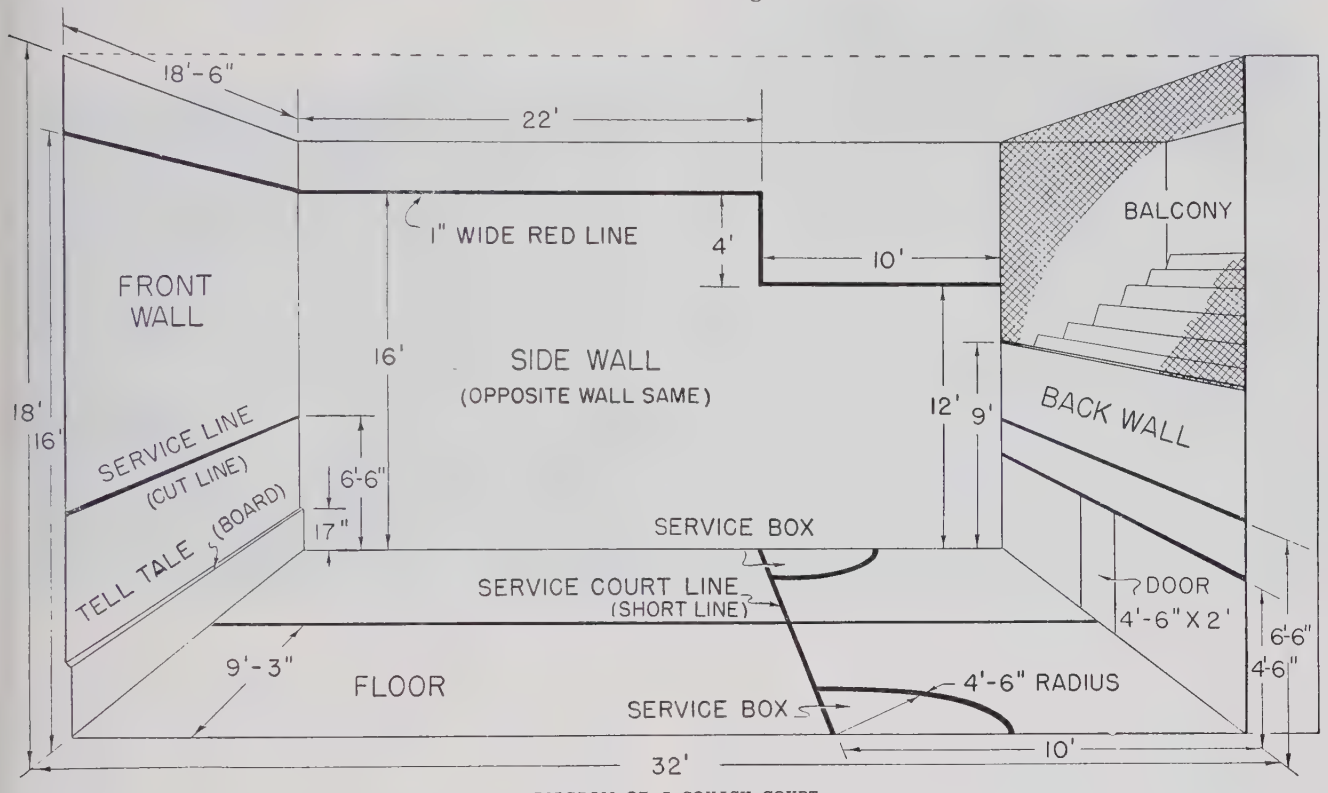


*DIAGRAM OF A SQUASH COURT*

Each player is obligated to give his opponent immediate and free access to the ball, plenty of space in which to execute his stroke, and free passage for the ball to any part of the front wall and the side walls near the front wall. He should not stand either directly in front of his opponent or very near him when he is striking the ball. Interference is subject to rules which can result, when there is a referee, in the point being awarded against the offending player. Usually, interference is only occasional and accidental; the player who has hampered requests a "let," play ceases, and the point is played again. Since rules are subject to frequent change, it is good practice for the beginner to obtain the latest regulations.

**American Scoring.** A match is the best of five games; the player who first wins three games wins the match. A game consists of 15 points, with certain exceptions. If the score reaches 13-all, the player who lost the tieing point must "set" the game at 15, 16, or 18 points; if he elects "three out of five," he is setting the game at 16, and so forth. If the score reaches 14-all without first having been 13-all, the loser of the tieing point must set the game at 15 or 17—one point, or three out of five. One minute is allowed between games; five minutes between the third and fourth games; otherwise play shall be continuous.

**Squash Tennis.** A variation of squash racquets, squash tennis was played in the early 1890's in the Middle West and the East. A racket, resembling that used in lawn tennis, but smaller, and an inflated ball, like a tennis ball with a web covering are used. The more lively ball makes squash tennis a speedier game than squash racquets, but otherwise the game is similar both as to court and method of play. Except in New York City, squash tennis has been largely superseded by the more popular squash racquets. J. M. B.

**SQUAWBERRY.** *See* PARTRIDGEBERRY.

**SQUEERS, WACKFORD,** villainous schoolmaster of Dotheboys Hall in Dickens' *Nicholas Nickleby*. His wife and daughter assist him in the outrageous mistreatment accorded to his pupils. DeL. F.

**SQUID,** the popular name for members of the ten-armed cephalopods of the suborder Decapoda. They are active, carnivorous animals found in every sea, where they prey on fishes and crustaceans. Some of them live on the surface

while others stay at great depths. They swim quickly by means of fins, but when greater speed is necessary they propel themselves backward by forcing jets of water from the mantle cavity through their "siphons." When defending themselves they can disappear behind a cloud of sepia or "ink" which they expel from special sacks within their

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*SQUID,* LOLIGO PEALII

bodies. The bodies of squids are usually long and conical provided with ten tentacles around the mouth. The shell is inconspicuous and located inside the body. *Architeuthis princeps,* sometimes reaching 50 ft. between the ends of the tentacles, is the largest known invertebrate. *Loligo pealii,* about 1 ft. long, is the common squid of the Atlantic coast. *L. opalescens,* the common squid of the Pacific, is the species popular in the Chinese markets. V. L. L.

**SQUILL,** *Scilla,* the common name of a genus of the lily family, with about 80 species of perennial, bulbous plants, widely found in Old World temperate regions. They bear blue, white, or rose flowers, generally in early spring. They have narrow leaves and usually low, erect flower stems. Many are cultivated as ornamentals. The bluebell of England, *S. nonscripta,* growing to 15 in. high, blooms in late spring. The Siberian scilla, *S. sibirica,* growing to 6 in. high, has vivid blue flowers, blooming in earliest spring. In medicine, the bulb of the sea onion, *Urginea maritima,* a member of the lily family native to the Mediterranean region, is used for its emetic properties; a preparation of the root is sold as "syrup of squills." J. C. Wis.

**SQUINCH.** *See* ARCHITECTURAL TERMS.

**SQUIRE, SIR JOHN COLLINGS** (1884- ), English critic, editor, and parodist, was born in Plymouth, England, Apr. 2, 1884. Educated at Blundell's School and at St. John's College, Cambridge, he began his career as a journalist, an apprenticeship that has, in many respects, influenced his subsequent work. He was associated with the *New Statesman* and founded the *London Mercury,* an influential literary publication of the 1920's and 1930's. He was knighted in 1933. Although he made his influence felt as a critic, particularly after World War I, he is especially admired as a writer of parodies, some of which were published in *Collected Parodies* (1921). Squire also wrote *Essays on Poetry* (1924), *Apes and Parrots* (1928), *Sunday Mornings* (1930), *Water Music* (1939), *Poems of Two Wars* (1940), and *Collected Poems* (1948). H. H. Wa.

**SQUIRREL,** a sciuromorphic rodent of the family Sciuridae. The word is used either to mean any member of the family, including such forms as chipmunks, ground squirrels, prairie dogs, and woodchucks, or, in the more usual sense, to refer only to the tree-dwelling forms of the genus *Sciurus.* Tree squirrels are present over most of the world, being abundant on all continents except Australia and Antarctica. Squirrels are medium-sized rodents, making nests in the branches or hollow trunks of trees, and spending most of their lives in the trees, though they descend to the ground for food or to move from tree to tree. There are two to six young in a litter, and usually a single litter per year, though in some forms there are two. Their food is largely seeds, nuts, and berries, though some forms, particularly the chickaree, will eat birds' eggs and other animal food. The gray squirrel can be very easily tamed, and is the friendly animal familiar

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*THE COMMON OLD WORLD SQUIRREL,* SCIURUS VULGARIS

to everyone in parks and other locations adjacent to humans. There are several fossil squirrels known, but the evolution of the group is not understood. *See also* CHICKAREE.

A. E. W.

**SQUIRREL CORN,** a smooth perennial herb, *Dicentra canadensis,* of the fumitory family, native from Nova Scotia to Virginia and westward. It grows as high as 6 in. from small yellow tubers, and has finely divided, greyish leaves. Small clusters of nodding, fragrant, greenish-white flowers, tinged with pink, appear on this herb in early spring.

J. C. Wis.

**SQUIRRELTAIL GRASS,** a common name for several grasses which bear brush-like flowering spikes resembling a squirrel's tail. Chief among these is *Hordeum jubatum,* an ornamental biennial, or perennial, growing as high as 2½ ft., of north temperate regions. It is a dangerous weed in the western United States, where its long, barbed awns are a source of injury to livestock. J. C. Wis.

**SQUIRTING CUCUMBER,** a trailing, hairy perennial, *Ecballium elaterium,* of the gourd family native to the Mediterranean region, and grown for its medicinal uses and interesting fruits. It has rough, heart-shaped leaves, yellow flowers, and small, oblong, greenish fruits, covered with soft prickles. When the fruit is ripe, internal pressure forcibly ejects the stopper-like fruitstalk, and the mucilaginous juicy pulp and brownish seeds are squirted out through the stem opening. The juice, containing the alkaloid elaterin, is dried in flakes to form the drastic cathartic drug elaterium. J. A. Bo.

**SRINAGAR** [srinʌ′gər], the capital and largest resort of Jammu and Kashmir, in the northwestern part of the Indian subcontinent. The city, about 400 mi. northwest of Delhi, India, is on the banks of the River Jhelum in the Vale of Kashmir, between the Pir Panjal Range of the Himalayas on the southwest and the main Himalayan ranges on the northeast.

Srinagar is at an elevation of 5,200 ft. above sea level. Its natural and artificial lakes, rivers, and canals, form a labyrinth of waterways in and around the city. The River Jhelum winds through the city and is crossed by seven bridges. Along the banks are moored houseboats which are the permanent homes of many of the inhabitants. The January temperature averages 35° F., but July has an average of 80° F. About 27 in. of rain falls, mostly in July and August.

Srinagar has a large silk industry, which used to make parachute silk for the British Army. Rugs, shawls, embroidery, wood carvings, art objects, and jewelry are made in small shops, and there are numerous small lumber and boat yards. Some fruit is canned and exported. The surrounding region provides mulberry leaves for silk worms; among other products are saffron, nuts, goat skins, fruits, and vegetables. Pop. 1941 (latest available), 207,787. J. E. F.

**STABLE FLY,** or biting housefly, the common names of *Stomoxys calcitrans,* a relative of the common housefly. It is also known as the dog fly. It has long shining-brown mouth parts that are swollen at the base, and it is a vicious biter of man and animals. It breeds in manure rich in straw, in decaying grass or other vegetation, and in the seaweed washed up by storms along the shores of lakes and seas. The life cycle requires only two to three weeks in warm weather. This fly has been suspected of transmitting infantile paralysis, and it is known to transmit trypanosomal infections to animals. Stable flies are a little over ¼ in. long. C. H. Cu.

*Stable fly,* Stomoxys calcitrans, *a dipterous insect resembling the common housefly, is found abundantly in stables and other farm buildings.*

**STACCATO.** *See* Musical Terms.

**STACHYOSE.** *See* Sugar Chemistry (*Oligosaccharides*).

**STADIUM,** in modern usage, a large structure containing seats for spectators, which surround a central area for competitive sports or other public exhibitions. The word "stadium" comes from the Greek *stadion,* a unit of length equal to 606 ft., 9 in. This was the distance of the original Olympian foot race, which was named for the measurement. The term was later applied to the area where the race was run, and, since the site had terraced rows of seats along the sides of the track, the name was carried over into modern usage to describe structures combining space for sports and seats for spectators.

*ROSE BOWL, PASADENA, CALIFORNIA*

SPENCE AIR PHOTOS—EWING GALLOWAY

**History.** The Greek *stadion* at Olympia and the Colosseum in Rome were the principal stadiums of early times. The Colosseum, most noted of all amphitheatres, had an extensive underground passage system and could be flooded for mock naval battles. Stadiums, however, declined in importance with the fall of Rome and were of little or no consequence during the Middle Ages. It was not until the revival of spectator sports in modern times that a new interest in such construction arose. The first modern stadium was built in Athens, Greece, in 1896 for the modern revival of the Olympic Games. It seated 66,000 and was a reconstruction of an ancient marble stadium.

**Modern Stadiums.** A few other stadiums, including bullfighting arenas in Spain and Mexico, were built before 1900, but the era of large modern structures of this type dates from the beginning of the twentieth century. Most of the large stadiums in the United States were built between 1900 and 1930. Indoor arenas were also constructed in this period, including the Chicago Stadium, seating 20,000, and New York City's Madison Square Garden, with a normal capacity of 18,000.

The United States has several of the largest stadiums in the world and has more than twenty-five with seating capacities exceeding 50,000. These capacities vary with the event,

since temporary seats are often erected on the perimeter of the exhibition area. For instance, Soldiers Field in Chicago can seat a maximum of 101,180 at football games; on other occasions, when seats can be erected on the field proper, a maximum of 200,000 people can attend events. The Los Angeles Memorial Stadium (The Coliseum) has a normal seating capacity of 101,671. The Philadelphia Municipal Stadium seats 98,993 while the Rose Bowl in Pasadena, Calif., holds 89,093. Many American universities have large stadiums primarily designed for football games. The stadium of the University of Michigan seats 98,000, and that of Stanford University, at Palo Alto, Calif., 90,000. The Memorial Stadium of the University of California and the Sugar Bowl (the stadium of Tulane University in New Orleans) seat over 80,000. The University of Pennsylvania's Franklin Field in Philadelphia has a capacity of 78,205, while the stadium of Ohio State University and the famous Yale Bowl both have seating capacities in excess of 70,000. The Harvard Stadium, one of the oldest in the country, seats 57,750 with added steel stands enclosing the open end of the stadium.

HARVARD STADIUM, BOSTON, MASSACHUSETTS

EWING GALLOWAY

Major league baseball parks generally have smaller capacities than football stadiums because of the fact that the play is concentrated in a smaller area. The largest stadium used by a major league baseball team is the Cleveland Municipal Stadium which holds 78,192. Yankee Stadium in New York has a capacity of 67,000. Other baseball parks with capacities exceeding 50,000 are Briggs Stadium, Detroit; the Polo Grounds, in New York; and Comiskey Park, in Chicago.

The Olympic Games, which in ancient Greece were responsible for the original stadium, have prompted the construction of some of the most important modern stadiums. The Athens stadium in 1896 was the first. London's White City Stadium, the first modern stadium in England, was constructed for the 4th Olympiad in 1908 and used again for the 14th Olympiad in 1948: it includes a cinder track, a swimming pool, and a bicycle path. The stadiums built in Stockholm in 1912 and in Amsterdam in 1928 were for the 5th and 9th Olympiads, respectively. The Coliseum in Los Angeles, built originally in 1923, was extensively enlarged for the 10th Olympiad in 1932. Germany constructed the huge Berlin Stadium, seating 140,000 people, for the 11th Olympiad in 1936. (Another German stadium, the Nazi Sportspalast in Nürnberg, erected in 1937, had a maximum capacity of 225,000.) One of the most modern stadiums in the world, built in Helsinki for the 1940 Olympic Games, which were cancelled because of World War II, was eventually used for the 15th Olympiad in 1952.

**Shapes and Types.** Most modern stadiums are based on Roman and Greek examples. The enclosed arena, or bowl, is similar to the Roman style, while the open end, or horseshoe type, is patterned on the Greek. Seating arrangements, exit locations, and ornamentation closely parallel the ancient models. Most stadiums are elevated; that is, the seats are constructed entirely aboveground around the playing area. Some, however, are constructed on the banks of natural or man-made depressions, with the playing field below normal ground level. Stadiums generally accommodate several sports, although they may be originally designed for only one. Baseball parks and municipal stadiums may be used for football, baseball, track and field, boxing, automobile and motorcycle racing, and other sports. However, the primary sport for which a stadium is designed governs its shape. Football stadiums are commonly single-tiered and have the greatest number of seats along the side lines, although seats usually extend all around the playing field. Baseball, on the other hand, concentrates the seats around the infield, where the principal action occurs. This leads to two- and even three-tier structures, such as Yankee Stadium and the Cleveland Municipal Stadium. Rows of seats are tiered and curved so that the playing area is easily seen from all points.

The grandstands in use at race tracks and automobile raceways, such as that at Indianapolis Speedway, are one-sided and front on only a portion of the track.

H. A. Br. and W. N. W.

**STAËL-HOLSTEIN, BARONNE DE** [stɑ'l ɔ'lste'n] (1766-1817), French woman of letters who was usually known as Madame de Stael, was born Anne Louise Germaine Necker on Apr. 22, 1766, in Paris. She was the daughter of Jacques Necker, the Swiss banker who became Minister of Finance to Louis XVI, and of Suzanne Curchod, brilliant daughter of a Swiss clergyman, who had been the youthful love of the English historian Edward Gibbon. Germaine

MADAME DE STAËL

FROM AN ENGRAVING OF A PAINTING BY GERARD

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Necker was a precocious child, and her intelligence and emotions were stimulated by the heady conversation of some of the best minds of the age in the famous salon of Mme. Necker. In 1786 she was married to the Baron de Staël-Holstein, the Swedish Ambassador at Paris, and thus acquired a position which enabled her to satisfy her ambition of establishing her own salon and playing a role in politics.

At first Mme. de Staël welcomed the French Revolution with enthusiasm, and her salon became the center of the constitutional party. However, she was forced into exile numerous times, especially under Napoleon, with whom she seems at one time to have had the vague dream of associating herself in power. Her *De la littérature* (1800), animated by a love of republican ideas of freedom and expounding the doctrine of perfectibility, made her suspect to Napoleon, who ordered her to withdraw forty leagues from Paris. *De l'Allemagne* (1810, 1813) was an even greater challenge to the Emperor. Its development of a theory already adumbrated in *De la littérature,* namely, the superiority of northern European Romantic literature over southern European, Classical literature, made it an important early manifesto of Romanticism. The book idealized Germany, which Mme. de Staël had learned to know well during her exile. Napoleon had the plates destroyed, and it was only in 1813 in England that the book finally saw the light.

Not being able to engage in politics during her exile from Paris, Mme. de Staël had turned to fiction and composed *Delphine* (1802) and *Corinne* (1807), both thinly veiled autobiographical novels that plainly show the influence of Rousseau. The latter, a far superior work, besides constituting an excellent guidebook to Italy, presents an idealized portrait of the author, giving her the physical beauty which she lacked and craved and portraying the difficult existence of the intellectually and artistically superior woman. After a long and stormy liaison with Benjamin Constant, Mme. de Staël secretly married (1812) a young officer, Albert de Rocca, who was half her age. After the fall of Napoleon she returned to Paris, where she died, July 12, 1817. R. A. P.

**STAFFORD,** county town and municipal borough in Staffordshire, England, situated about 120 mi. northwest of London, on the Sow River. It is a manufacturing center. It was formerly named Betheney and as such is mentioned in the Anglo-Saxon Chronicle. About 1050 it had a royal mint. William the Conqueror built a castle in Stafford, which was dismantled by Oliver Cromwell. The first charter was granted by King John in 1206. In 1918 Stafford was included in the parliamentary division of the county. The area of the town was extended in 1934. Izaak Walton was born and died in Stafford and was baptized in St. Mary's, the parish church which was built during the Anglo-Saxon period. The manufacture of boots and shoes is the principal industry. With Stone, Stafford returns one member to Parliament. Pop. 1954, 40,750. A. W.

**STAFFORDSHIRE,** a central Midland county of England, with an area of 1,158 sq. mi. It is bounded by Cheshire and Derbyshire on the north, Derbyshire and Leicestershire on the east, Warwickshire and Worcestershire on the south, and Shropshire on the west. The Trent River Valley intersects the county in a northwest-southeast direction. The northern part of the county is mostly wild moorland; the rest is level or gently undulating. Staffordshire is the third most important industrial county of England, but much of it is still rural. The Potteries, the earthenware manufacturing district, is celebrated as the Five Towns of Arnold Bennett's novels. The area really has six large towns: Hanley, Burslem, Stoke-on-Trent, Longton, Tunstall, and Fenton. The pottery industry is an old one. Josiah Wedgwood started his factory at Etruria, the Spodes theirs at Stoke, in the eighteenth century. The Black Country, famous for its iron manufacturing, is in southern Staffordshire. Wolverhampton, the capital of the Black Country, has been known since Elizabethan times for its locks and keys. It now has ironworks and hardware manufactures of all kinds. There are valuable coal fields in the county, and gypsum and zinc ore are mined. Salt is made from brine here, and there are breweries at Burton-upon-Trent, and silk spinning and dyeing establishments at Leek. Stafford, the county town, birthplace of the angler Izaak Walton, manufactures boots. Dr. Samuel Johnson was born at Lichfield. The county returns six members to Parliament. Pop. 1952, 1,620,000. S. Van V.

THE TRAVEL ASSOCIATION

*Memorial to Dr. Samuel Johnson in the Market Place at Lichfield, Staffordshire*

**STAG BEETLE,** the name given to a family of large beetles, the Lucanidae, which usually have greatly developed mandibles in the males, suggesting the antlers of male deer. Although the beetles are able to pinch quite strongly, they are entirely harmless. The mandibles, which are chiefly ornamental, may be used for grasping the female during mating. The male is known to use them in fighting. This group includes the largest beetles, which may be over 4 in. long. Stag beetles are often called pinch bugs. C. H. Cu.

**STAGE,** the separate place in the theatre where plays are enacted.

Development of the stage is connected with the appearance of the actor in the antique theatre who used the supporting steps (*bema*) of the altar (*thymele*) during his presentation. He moved later to the open section of the auditorium (*theatron*), outside of the orchestra circle, in order to find himself in a more frontal position to his audience. A wall, later a wooden hut (*skene*), acted as a background, and the projecting wings (*paraskenia*) served to enclose the actor in a courtyardlike space, while framing his movements against the open landscape.

The actor soon achieved a desired dominating height by occupying the roof of the skene building (*logeion*), thus originating the first "stage." The higher level (*theologeion*), required for the appearance of the deities in the Classic tragedies, brought about the construction of an additional level resulting in an architectural repetition. With these innovations the antique theatre developed the basic form of the stage as an elevated, distinct place reserved for the actor. The use of different doors, such as the center door (*porta regia*) for royalty, and side doors (*hospitalia*)for slaves, gave the first symbolic significance to the place of the action.

During the fourth century B.C., the Greek theatre, which was originally a religious-ceremonial assembly place, witnessed a gradual transformation into a more theatrical auditorium. First came an attempt toward straightening out of the seats (Dionysos theatre). Later, the elimination of the overhanging wings resulted in a reduction of the size of the theatron, this being the first attempt to decrease the distance between actor and audience. The art of portrayal was still restricted to the person of the actor, yet sporadic scenic effects appeared. The abnormal height of the logeion gradually decreased. With emphasis on the theatrical element, the Roman stage grew to enormous proportions, finally occupying half of the orchestra circle and stretching over the whole diameter (180-300 ft.). The façade of the building itself, the richly decorated *scaenae frons,* represented a further advance toward scenic ideals, remaining, however, only an architectural ornament. Therefore, the stages of the antique theatre were classified as an architectural stage of permanent nature (*scaena stabilis*).

There were no permanent theatre buildings in the Middle Ages, and the stages for their occasional performances therefore consisted mostly of various types of simple platform construction erected on public squares (Lucerne, Valenciennes) or they were placed on wheels and drawn through the streets of the village (English pageant wagons). The illustration of Biblical themes was the motivation of these performances as arranged by the Church. This resulted in the employment of scenic representations, e.g., The Manger, Heaven, Prison, and Hell Mouth. These Mystery plays demonstrate how the art of portrayal of the actor spread to his environment. The "little mansions" (*domus*) were placed at the back of the platform in a row, creating the so-called *décor simultané.*

With the discoveries of the laws of perspective, the Renaissance architects Bramante (1444-1514) and Sebastiano Serlio (1475-1554) developed the "angle wing" type of setting, which enabled them to present the illusion of larger space conceptions, such as a public square or the vista of a whole city or garden. These settings were far more effective than the "little mansions" of medieval practice. Placed on a sloping stage, the vistas served for background, behind the actual platform used by the performers. Simultaneously, the interest of the humanists in antique culture resulted in the revival of ancient tragedies and with them the corresponding performance practice. The Teatro Olympico in Vicenza (1584), based on plans of Vitruvius Pollio, the Roman architect, was a replica of Roman architectural stages complete with the traditional five doors. The Serlian type of perspective vistas was placed behind the openings of the *scaenae frons.* In his book on architecture Serlio left a description of this stage upon which, in accordance with ancient tradition, three types of settings could be exhibited, i.e., the tragic, comic, and satyric scenes. Serlio used perspective scenery, painted on angle wings and mounted, three on each side, on a sloping rear stage which was terminated by a back shutter. His stage had unwieldy stability, though it was not as rigid as Palladio's Teatro Olympico stage built during 1580-1584. The increasing importance of the ever-changing colorful settings of the *scaena mobile* was soon recognized by Giovanni Battista Aleotti, who in the Teatro Farnese (1618) enlarged the opening of the *porta regia* to such an extent that the full width of the stage floor was filled with a single vista. This first modern setting, by eliminating the permanent architectural stage, placed the actor on the same stage with the scenery. The *porta regia,* transformed into a proscenium arch, created a sharp dividing line between stage and auditorium, making two separate architectural units. While the architectural type of stage was carried on by the Elizabethan theatre in the use of the apron stage without scenery, in the proscenium type of theatre the actor and his environment became framed, and the "peep show" stage made every effort from this time on to convert itself into a "world of illusions."

Demand for quick scenery changes for the "intermezzi" or interludes between the acts of the legitimate plays overtaxed Serlio's efforts. An inspiration from Vitruvius' treatise on architecture solved the problem. Architects found that the Greeks used the *periaktoi* to indicate scene changes. The Renaissance architects reviewed these triangular revolving prisms and proceeded to use the idea. The designer Bernardo Buontalenti became famous (1585-1589) for his *a vista* shifts of scenes painted in perspective.

The stage designer Sabbatini invented (1637) a number of mechanical devices modeled on the triangular prisms, e.g., *scaena versatilis,* in order to surprise the audience with quick-changing settings. Shortly after this invention, the angle-wing system was replaced by free-standing wings sliding in grooves on the stage floor (*scaena ductilis*). This improved method gave even more opportunities for variation in shape and subject. While the number of different settings employed within one presentation continuously increased, more and more machines were employed to satisfy the ever-growing desire for spectacle. During the seventeenth century complete triumphal processions were transferred to the theatre, which demanded extraordinary depth of the stage (Salle de Machines, Paris, width 33 ft., depth 130). Flying angels and goddesses descending from the clouds required the development of extensive flying space above the stage. The counterweight system operated by drums and pulleys was in common use for lifting the drops and borders of the fantastic settings of the Bibienas (eighteenth century). The fly galleries received further importance in operating the enlarged drops and arches of the nineteenth-century Classic and Romantic eras. Although surpassed by present-day technique, they still can be found in many contemporary modern theatres. The rigid separation of stage and auditorium culminated in the satirically called "mystical abyss," under the demand of Richard Wagner in the construction of the Festspielhaus in Bayreuth, where the unusually deep orchestra pit represented an insurmountable barrier between stage and auditorium.

The decline of the theatre of illusion toward the end of the

nineteenth century resulted in the change from the merely painted scenery to the three-dimensional, plastically built, naturalistic settings. This innovation presented a new demand in scene change devices. Thereafter, revolving panels, elevators, and rolling wagons were installed in the stage floor for handling the massive set pieces. With the replacing of illusion-creating settings by the physical realities of built-up scenery, the framing function of the proscenium arch became obsolete and gave new opportunities to the pioneers of the modern experimental theatre (Max Reinhardt, Walter Gropius, Usevolod E. Meyerhold). These modern experimenters, in order to balance the close-up technique of the cinema, and perhaps to exploit new beauties of three-dimensional space, are seeking to establish a closer relationship between actor and audience. Modern designers, by introducing various types of apron, relief, and space stage construction are trying to break into the domain of the auditorium. This trend has resulted in the appearance during the 1940's of the arena type of theatre plan, as well as actual performances with completely circular auditoriums (Pent House Theatre, Seattle, Wash.; "170 Productions" of Ralph Freud at the University of California at Los Angeles).

E. Na.

**STAGE PRODUCTION IN THE UNITED STATES.** With the possible exception of the motion picture, there is no other art that depends for its completion on so many elements, so many people, and such diverse talents as the art of stage production. After an author has written a play, it is not fulfilled until it is brought to life. Its words must be spoken by living actors, who move before the eyes of an audience, make their entrances and exits, and enact the story.

When a theatrical producer buys a play, he is concerned with this very task of bringing the written word to life. He must find the financing and engage the director, and then, with the approval and help of the director and author, he engages the cast and the scenic and costume designers. When a star is engaged for the play, he or she will have a voice in some of the decisions, especially in those regarding the supporting cast, the designers, and the general character of the production. Often the producer is his own director, and sometimes an author will direct his own play. In any case, director and producer must work closely together, and, when a modern play is presented, the author also has considerable authority. Over-all responsibility for the production lies with the producer, but the director is the guiding hand.

A. F. B.

**Direction.** Stage direction is the art of bringing to life on the stage the characters and incidents that have been imagined in a dramatist's manuscript. The manuscript may be likened to blueprint designs of a machine. It is the director's function to assemble the parts, put the machine together, and make it run. His work begins with the dramatist, to whom he may point out parts that, to him, seem defective, overstressed, or understressed. The director's next function is to work out with the scene designer the mood and treatment of the settings, costumes, furnishings, and lighting.

From the beginning, the director has been surveying casting problems, and if these are found seriously insoluble actual production is delayed. Casting completed, the director starts rehearsals, and here begins the welding of all elements into one all-inclusive pattern, as originally envisioned. To the extent that he succeeds, he will reveal a smooth-running machine, with all parts so functioning that no part falters, clatters, or shakes loose.

Until comparatively recent times, the stage director, as the co-ordinator of all departments of presentation, was little known. The physical production was largely left to the scene painter, the property master, and the manipulator of lighting. The direction of the actors was largely in the hands of the leading actor or, occasionally, the author. There was no planned over-all pattern. Augustin Daly (1838-1899) was perhaps the first American stage director as direction is now understood. Following him, and further pursuing the method of full authority over all expressions, from the virgin manuscript to final birth, was David Belasco (1854-1931).

Relations between director and cast vary. There is the director who wants to act all of the parts, who sees actors not as creators but as imitators. Far removed from the thespian director is the director who tries to stimulate the actor's own creative potential. To the extent that the projection is imitative, the director is to be given full credit or blame. To the extent that the interpretation is creative, both actor and director are involved. In the final analysis, the director must assume full responsibility for all that has been permitted, encouraged, or discouraged, for the whole effect is the director's —the essence, the flavor, the illumination.

When direction is perfect, it will be unnoticed. The director's methods, like the magician's, should not be evident; he is clumsy if the rabbit is seen getting into the hat. The stage at its best is legerdemain and hypnotism, and these are the arts of the stage director.

A. Ho.

**Design.** Usually a stage designer has an opportunity to read the play that is to be given before he is engaged for the production. Then he and the producer agree on dates for the delivery of designs, scenery, props (properties), and costumes, as well as the dates for rehearsals and for the opening performance. After further study of the play to determine the type of design best suited to the script and to the budget, the designer makes a sketch, or more frequently several sketches, of his settings. These he submits to the producer along with floor plans of the settings, showing plainly the location of entrances and exits, windows, fireplaces, the masking pieces, the cyclorama, and the outside dressing; he will also indicate the placing of the principal pieces of furniture. The floor plans are most important, for the action of the play is contained in them, and from the floor plans grow the elevations, or the walls of the room, or, in an exterior scene, the trees, shrubs, walls, or masking pieces. With all of these drawings, the designer gives color samples of walls, woodwork, furniture covering, drapes, and so forth. There are many ways to design a play and each person concerned with the production has ideas of his own, but the director knows what he wants and the final decision rests with him.

*Scenery.* Stage scenery is built of wood, covered with canvas, and the canvas is painted to simulate whatever is indicated in the design. Certain parts of the scenery, such as doors, window frames, mantelpieces, and columns, are built separately and are stained or painted as required. When the designs are approved, the designer makes his measured drawings for the builders. These are carefully dimensioned, half-inch-scale mechanical drawings; from them blueprints are made, and enlarged details are drawn up wherever necessary, usually for fireplaces, moldings, or ornamental details. A one-act play usually requires two or three sheets of drawings; an elaborately designed musical or a play of many sets requires as many as ten or twenty sheets. Sometimes a scale model is made; but most directors and producers are content with scale drawings.

Scenery paint is a mixture of powdered pigment, glue,

size, and water. Color samples are usually made in water color or tempera, for oil color has a different quality and samples in oil could not be exactly reproduced. Where a room is to be done in wallpaper, the design must be furnished to the painter, since no real wallpaper is ever used on a set of scenery; such paper is not fireproof, it is seldom correct in scale, and it is flat and uninteresting. Wallpaper designs are reproduced on scenery with a series of stencils. A half-inch-scale painting of every backdrop is made, as well as paintings of borders, side pieces, and masking pieces.

When the contracts for building and painting are assigned, it is the duty of the designer to supervise the work in progress. No matter how precise the drawings, there can always be differences of interpretation, and the designer may be obliged to pay almost daily visits to the builder. Stock moldings and trim are often used, and if so the designer selects them and their numbers are marked on the blue print. On completion, the scenery is shipped to the painter's studio, where the painter makes samples of color on a piece of canvas or an old piece of scenery before starting work on the sets. Scene painting is not just flat laying on of color, like house painting; it is a process of vibrant painting, one tone applied over another in order to create the illusion of atmosphere. Under the changing light of the stage, surprising variations in color may develop, and in order that the designer may have his finished scene exactly to his taste, he must supervise the painting job during the entire time that it is in progress.

*Props.* Theatrical properties are everything that is seen on the stage except scenery and costumes. The draperies, carpets, furniture, pictures, ornaments, trays, knives and forks, plates, cups and saucers, cigarette boxes and ash trays, artificial flowers, books, lamps and lighting fixtures, trees and shrubs—the countless things that give reality to the set—are all procured by the designer. All are under the care of the property man except the lighting equipment, for which the head electrician is responsible. The property man will sometimes furnish things that do not come within the sphere of design, such as false money, foreign or outdated newspapers, or old letters, but even these are usually submitted to the designer before being used. Stage telephones are the responsibility of the electrician.

The assembling of props is a long and tedious business. Before going into rehearsal, the director decides how many pieces of furniture he wants and where they are to be placed on the stage, but this decision is subject to change as work on the play progresses. The director's needs must always be satisfied, by purchase or otherwise, even though such specifications as the height or depth of a sofa are not easily met. The renting of props, whenever it is possible, is a common practice, for it results in a great saving in the initial cost of a production. Props that cannot be found must be made, and remarkable representations of real objects are turned out in studios that specialize in such work. For example, pot-bellied iron stoves, marble statutes, foods of all sorts, Welsh harps, and street organs can be reproduced in papier-mâché at a fraction of their true weight.

The property man is also responsible for off-stage noises such as galloping horses, shattered glass, pistol shots, sustained gunfire, thunderstorms, and banging doors. He has noise machines, a drum for thunder, a coconut shell manipulated on a board by hand for the horses' hoofs, and phonograph records for bands and crowds, but he uses a real door in a frame to produce the sound of a banging door and real glass for shattering. Off-stage noises often raise perplexing problems. In Chekhov's *The Cherry Orchard,* for example, the author's direction is: "At this point a sound is heard like the breaking of a harp string." In one production of the play, the sound thus indicated was found to have no resonance, and, after many experiments, the desired effect was obtained from the twang of a musical saw.

*Costume.* The moment an actor comes on the stage to play his part, he is in costume. He wears the particular kind of dress that the man he represents would wear, just as he speaks the words the author has written for the character and not his own words. The costume of the actor is the heightening, the translation into terms of character, of everyday clothing; when this is successfully done, the designer is not merely a copyist, but a creator.

As he reads the play, an experienced designer forms a mental picture of the costumes, just as he does with the scenery. He makes sketches and then confers with the director, sometimes also consulting the principal actresses and actors before completing his drawings or ordering his costumes. A costume must be correct in line, period, and character; it must suit the actor or actress; and it must be in harmony with the rest of the production. Costumes for the entire cast must be designed as a whole, in relation to each other and to the scenery and movement of the play. In color they must harmonize with the draperies and the furniture covering.

The execution of costumes is difficult, for most costume drawings are not clear statements of design and they are interpreted with great latitude. Costumes can be made from numberless kinds of material, and since the quality, weight, and pattern of a fabric are of primary importance to the success of a design, the task of selection requires talent of a high order. Costumes for plays in a modern setting, if they are not specially designed, are usually bought or made to order; those for period plays are usually rented. In any case, they must be fitted to the wearer in the short time (normally three or four weeks) allowed for rehearsals. The designer is obliged to supervise the fittings, and it is a measure of his responsibility that much of the success of a costume depends on whether or not it is worn by the actor or actress with confidence. The effect of lighting requires careful consideration, and many directors call for a dress parade on the lighted stage after the costumes are completed.

*Lighting.* Lighting the stage is an important part of the designer's work. With his blueprints he gives the manager a light plot, indicating how much equipment he will need and where it will be hung. The head electrician is engaged for at least a week before production opens and is often present when the equipment is ordered. Lighting units are rented for nearly all productions, for there are no permanent lights on any stage of a commercial theatre, except possibly a border light, which is a long strip of ordinary lamps that cannot be focused or changed. It is unfortunate that all productions have to carry their own electrical equipment, for the cost of hanging and dismantling is very high; but this cost varies greatly, of course, with the type of play that is being produced.

Lighting is, in a sense, the final touch of any production. It permits an entire audience to see the movements and expressions of the actors; it enhances the beauty of the scenery and costumes; it establishes the time of day; and it creates atmosphere and mood. In general, it has the effect of fusing all the elements of a production in one harmonious whole.

Lighting equipment for the stage consists of electric lamps of different power, shining through lenses and modified by gelatin mediums of different colors. The lamps, or spotlights, have flexible frames so that they may be turned and

focused on the object to be lighted. They are hung on pipes overhead behind the proscenium arch, or at the sides of the proscenium, and some are placed on the balcony rail so that their rays can be directed across the auditorium to the stage. There is usually a strip of light known as an X ray, which is hung overhead among the spotlights and consists of four, six, or eight rigid lamps; there are also strips of lights that are used to illuminate the top and bottom of the cyclorama, and flood lights to give added brilliance. All of the lights are controlled from a switch board, with dimmers. Properly used, they will give exceedingly subtle and dramatic effects. New and better equipment is constantly being made by the lighting laboratories, and the advance in stage lighting has been one of the most notable technical achievements of the modern theatre.

**Final Preparations.** About three weeks and a half after rehearsal starts, the scenery, props, costumes, and lighting equipment are picked up by a theatrical trucking company and delivered to the theatre where the play is to open. Formerly, when costs were lower, it was the custom to hold a scenery and dress rehearsal in a theatre in New York, before shipping the material out of town; in fact, some plays opened in New York without benefit of tryout away from the city. Now, however, the material usually goes directly by train to wherever it is needed. Two or three days are allowed, in an ordinary production, for setting up scenery and lighting and for dress rehearsal. Many more are needed for elaborate productions with a number of scenes and for musicals and reviews.

The stage manager and the designer are in the theatre while the scenery is set up and the lights are hung. Every play that goes on the road has its own crew, including a head carpenter, a head electrician, and a head property man. These have as many assistants as the show requires, and there is, besides, a resident crew in every theatre. When the show comes to New York, the road crew remains with it, working with the crew that is assigned to the New York theatre. Since the cost of crews during rehearsal is high, all possible steps to facilitate the setting up of scenery are taken in advance. The head carpenter is largely responsible for this and, of course, for the proper designing and supervision of the scenery. No matter how carefully scenery is built, there are irregularities in the fitting of joints, doors, and window frames when it is set up in a theatre, owing to imperfections of pitch in the stage floors. In some of the old theatres on the road, floors sometimes slant upward as much as a foot toward the back wall, but stage carpenters have become accustomed to dealing with this inconvenience. While the scenes are being set, the electrician hangs the lights and makes his equipment ready for the work of focusing the spot and of covering the lenses with colored mediums.

As soon as the scenes are set, the property man lays the rugs, hangs the pictures, distributes the furniture and small stuff, and checks his off-stage props. The stage manager shares these responsibilities with the property man, for he knows what is needed for the action of the play. In fact, he is the representative of the director at this time. He knows what the positions of the cast are to be and at what point in the action the lights will dim or brighten, and he is responsible for giving the cues to the head electrician. The lights are now adjusted, the actors take their places, and the dress rehearsal begins. Thereafter, in the few days that may remain before the opening performance, changes in cast, in lines, and in scenes or costumes may be required. After the opening night, the production stands or falls largely on the merits of all the labor that has gone before.

### PRODUCTION OUTSIDE OF NEW YORK CITY

Play production in the United States is at present localized in New York, where most of the country's best builders, painters, property makers, and costumers are found. It is the central point for actors and actresses, except for those in the film industry on the West Coast. A great deal of the capital for production comes from New York; and the film companies that supply some of the capital place a higher value on a play that has won the stamp of approval of New York critics and audiences. A few plays are produced in Los Angeles, San Francisco, or Chicago, but they are negligible. Some plays enjoy a long run on the road before appearing in New York, opening in other cities, and touring extensively if business warrants; but the productions are made and rehearsed in New York. After the New York run, they may go on tour again. In the case of enormously successful plays, one or more additional companies may be formed, the scenery and costumes being duplicates of those in the original production.

Road travel is popular with the touring companies, for they are rewarded by the enthusiasm of the audiences and refreshed by new contacts with places and people. In the big cities, the run may be from one to four weeks or more; elsewhere, split weeks and one-night stands often require night travel, but the physical discomforts of the schedule are balanced by the excitement of the road. In spite of travel costs, a road company with a successful play may make a substantial net profit.

A few cities maintain their own stock companies. The plays that they present are usually Broadway successes, but occasionally there are revivals of the classics and, very rarely, a new play. The companies normally have a resident designer and scene painter and build and paint their scenery in the theatre. Costumes for period pieces are hired, and, unless something out of the ordinary is required, modern clothes are supplied by the actors and actresses. The plays run a week, as a rule, with the result that there is neither time nor money for creative designing. The designs of the original production are followed as closely as possible, the scenery is usually rebuilt and repainted from old materials, and the properties are gathered where and how they can be had. Although the productions may be shabby and uninteresting, these stock companies often develop an excellent quality in acting, a certain harmony that comes from association in work.

Summer theatres are a comparatively new operation in America. Like the stock companies, they also produce plays that have had the stamp of Broadway approval, but they produce new plays as well, some of them try-outs of later successes. As a rule, the summer theatres have a semipermanent company, fill out the cast with visiting stars or well-known character actors, and employ a resident designer and painter, supplemented by amateur help. Many young men and women learn their trades in a summer theatre. It is an excellent school, for the stage is usually small and the materials are limited, and designing under these conditions is a challenge to the imagination of the young designer or craftsman.

A. F. B.

**STAGG, AMOS ALONZO** (1862- ), American football coach, was born Aug. 16, 1862, in West Orange, N. J. He was educated at Phillips Exeter Academy and Yale University, where he played end on the varsity football team, being chosen on Walter Camp's first all-America team in 1889. Stagg studied for the ministry after graduating, but decided he lacked the necessary eloquence for the pulpit,

and in 1890 began coaching the football team of Springfield (Mass.) College, also playing as its captain. Stagg went to the University of Chicago in 1892 to head the physical education department, a position in which he remained for forty-one years, developing many of the greatest American football teams and players. He coached five undefeated elevens, won the Western Conference championship seven times, and tied once for the national championship, and his over-all record was 268 games won and 141 lost. During most of his stay at Chicago eastern teams dominated football, but Stagg made effective use of his material and in time became generally recognized as the country's leading originator of football plays. Among these were the principle of the hidden ball, the "ends back" play, the "turtle back," the end-around play, the fake kickoff, and the double delayed pass. Stagg also invented the tackling dummy.

An age-limitation rule forced Stagg's retirement from the University of Chicago in 1933, but although past his seventieth year "the Grand Old Man of Football" refused to end his coaching career, and the next year found him drilling a new team at the College of the Pacific in Stockton, Calif. The school was relatively small, but Stagg gradually built teams of major caliber, and his success was so outstanding in 1943 that the nation's coaches voted him "Coach of the Year." He left in 1946 to become advisory coach under his son, Amos Alonzo Stagg, Jr., at Susquehanna College. Stagg's high ideals and his devotion to football as a molder of character have been recognized in many awards and honors. He is the only life member of the Football Rules Committee. He was the only man chosen as both player and coach among the first members of the College Football Hall of Fame established at Rutgers University in 1951. He has co-authored *Treatise on American Football* (1893) and an autobiography, *Touchdown!* (1927). G. Q.

**STAGGERBUSH,** a member, *Lyonia mariana,* of the heath family, native from Rhode Island to Florida and westward. It is a slender shrub growing as high as 6 ft., having oblong leaves, and bearing numerous, handsome, nodding clusters of pinkish or white flowers, in late spring, on leafless branches. It is poisonous to livestock, especially sheep.
J. C. Wis.

**STAGHORN FERN,** an epiphytic, perching fern of Australia and the tropics of Asia and Africa. The fertile fronds, erect or drooping, branch in a way that gives the appearance of a pair of antlers. The sterile fronds are flat and rounded, and remain close to the support on which the plant grows. The common staghorn fern, *Platycerium bifurcatum,* and several other species are grown in conservatories. The spread of the fronds sometimes reaches 6 to 8 ft.
G. M. Sm.

**STAINED GLASS,** a term specifically used to refer to the translucent colored glass of the great pictorial church windows of northern Europe. The earliest of these windows date from the tenth century of the Christian Era, though colored glass itself had been known for many centuries previously. The Egyptians made glass imitations of precious stones. The Romans had opaque glass mosaic plaques and rosette ornaments of twisted varicolored strands. Later, in the Near East, a jewellike wall decoration was achieved by colored chips of glass set kaleidoscopically in the masonry or plaster. But none of these early applications can be considered fine art. Only when in the North stained glass became an adjunct of Christian architecture did it attain high artistic status.

**Origins.** Many characteristics of northern windows originated in southern and eastern countries. The use of glass to cover openings in buildings was introduced about A.D. 300 in the basilicas of southern Europe. It was the Arabs of the Near East who used translucent pieces of colored glass in walls of mosques and palaces and later devised geometric and floral designs resembling wall mosaics. It was the Arabs, too, who developed pointed window frames with delicate stonework. The marked influence of East-European Byzantine illuminated manuscripts and of cloisonné enamels, made also of colored glass and lead, is also apparent in the early Gothic windows.

It was in France, England, Germany, and the Netherlands, however, that the art of stained glass reached its fullest realization, and here it became one of the great achievements of European culture. Many factors influenced this development. A transcendent religious impulse was evidently necessary before the miraculous vibrant aspects of colored glass could be put to appropriate use. Light architectural forms were also needed, and Southern Romanesque architecture was too heavy to encourage display of elaborate glass; furthermore, the glare of harsh southern sunlight weakened the effect of translucent colors. But the most important factor was that it was in the North that the great religious revival furthered by Charlemagne reached its greatest intensity. A wave of church and cathedral building was started in the tenth century and was well underway in the eleventh and twelfth centuries.

To create picture windows, the knowledge of how to make glass in many colors was necessary. The color range of the ancient craftsmen had been too limited for pictorial compositions, but a general interchange and increase in knowledge took place when scholars and craftsmen fled westward to escape the Arab conquest, later, when the Crusaders traveled East. Thus around the ninth and tenth centuries the Medieval glass-makers learned how to produce many additional colors in "pot-metal," i.e., glass colored by various oxides or by gold or silver particles while molten and still in the crucible. They also developed the technique of "flashing," a process whereby a colored glass and a white glass are blown together and the resulting glass, in two layers, alters the intensity of the color.

**Techniques.** It is well to remember that lead as well as glass played an important role in stained glass windows, and lead strips as well as iron bars were an integral part of both construction and design. To construct the windows, the Medieval craftsmen used a whitewashed top of a trestle table which was at least twice the size of the proposed window panel. On one side was drawn the cartoon, or heavily outlined pattern; on the other side the glass was assembled. The process of construction, which remained basically the same for centuries, was something like the making of a jig-saw puzzle. The pot-metal was blown into a cylinder, cut, and flattened. A wetted fragment was placed over an outlined section, and cut to conform to the cartoon lines by the pressure of a red-hot pointed iron. Rough edges were smoothed and filed by a hooked "grozing iron" (diamond cutting was adopted about 1500). Then the pieces were placed in the proper position at the other end of the table.

After the pieces of glass were assembled, grooved strips of lead joined in the shape of an irregular "H" were inserted and soldered at the joints. These held the pieces of glass and lent both physical and aesthetic strength to the design. Finally, the finished glass panel was weather-proofed and elevated and attached by copper wires to iron saddle bars in the masonry of the window opening. It was in effect a great

mosaic of contrasting colors and dark lead lines. Some lines were painted in a brownish-gray pigment on the surface of the glass to define the facial expressions and the draperies. The pigment was made of powdered oxide, a powered glass, and putty and became known as "grisaille." Each fragment of glass on which lines were applied was painted separately and fired in a kiln at high temperature to fuse the pigment permanently to the surface. Another means of surface decoration was discovered early in the fourteenth century when silver oxide applied to the surface was found to color the glass a pleasant yellow tint of varying depth. This yellow tint extended the subtlety and variety of coloring.

The plan of the windows was from the outset carefully supervised by religious authorities, for the strong dramatic quality and emotional appeal were self-evident. The central workshops at Chartres, Bruges, and elsewhere, from which workmen, materials, and designs were probably often dispatched abroad, were under the direct charge of the clergy.

**History.** The earliest mention of pictorial church windows occurs in two tenth-century manuscripts that refer to the windows at Reims and to the leading of valuable windows at Fleury-sur-Loire. The earliest glass now in existence is at Augsburg, where five fairly small eleventh-century panels, each depicting a prophet, have a dignity and solemn majesty that is more Romanesque than Gothic. This is also true of the slightly later window, with exceptionally effective leading, at Canterbury showing the Patriarch Jared. There is a Byzantine quality apparent in these windows. Another variation of Byzantine influence is apparent in the only other existing eleventh-century glass window: the Ascension panel at Le Mans.

Typically, these early windows show prominent, often single, figures and use large pieces of glass, heavy leading, and often pastel colors. In the borders, when they occur, designs are formal, stiff, and stylized, and the motives often Classical in form. A conventionalized treatment of acanthus leaves is frequent.

The spirit of the windows changed in the mid-twelfth century when this comparatively stiff style was replaced by the introduction of medallion windows. The Gothic Cathedrals were described as textbooks in stone, and it is not surprising that the didactic possibilities of stained glass windows would soon be put to use by the Church. Instead of single figures as subjects, whole stories were presented chapter by chapter in medallions. The medallions, circular or, later, quatrefoil, were outlined by iron armature. The emphasis on storytelling caused window openings to become larger and higher, and the pieces of glass smaller and more detailed. The arresting features of the brilliant windows set in the dark interiors was exploited to the fullest by the increasing use of jewel tones and dazzling detailed backgrounds. The play of light was carefully studied. The use of blue and red which merged into purple was characteristic of the thirteenth century, especially in France, where these colors, in trellis-work background, are exemplified at their most dazzling in Sainte Chapelle, the curved walls being almost entirely of high glass panels. In England, scroll work filled in the intervals between medallions. After about 1250 the windows as a whole achieved a great liveliness and vitality. Border motives were rhythmic, more natural, and no longer strictly schematic. Franciscan gentleness and love of warmth and nature characterized many late thirteenth-century windows. Within the medallion framework, composition achieved compact force, and the color was of great brilliance. This is generally considered the greatest period of stained glass.

Probably the earliest medallion windows are those at Canterbury, Sens, and Chartres. The Cathedral of Chartres is the great treasure-house of twelfth- and thirteenth-century glass. It contains the blue Tree of Jesse window, the famous Belle Verriere window showing the Virgin and Child enthroned, and a great window depicting the Passion. There are three rose windows at Chartres. Circular rose windows are set high in a façade, and, because details of stories would not be visible at that height, they are not narrative but have instead radiating, isolated motives of design. The sections, frequently consisting of formal rosettes set in arches, point toward the circumference. The effect is kaleidoscopic and purely decorative. When, in 1926, the rose window at Reims, destroyed during the First World War, was restored, this form of design engaged the attention of many people previously unfamiliar with Gothic windows.

Eventually the splendor and color of the twelfth- and thirteenth-century glass gave rise to a counteraction. The Cistercian and later the Franciscan monastic orders issued edicts protesting the overly rich and worldly effects. These mendicant orders were the spiritual heirs of the Byzantine monks whose illuminations had inspired the use of jewel colors as a means of direct appeal and expression and who had also understood the religious needs of the individual communicants. The Franciscan and Cistercians also understood these needs and preached directly and comprehensibly to the people, extolling love of the small and humble and the virtues of the poverty and austerity present in daily life. In the thirteenth century the monastic orders acquired enormous power. Between 1221 and 1264, 8,000 Franciscan monasteries were established. When, at first in the mid-twelfth century and intermittently thereafter, their orders promulgated puritanical edicts prohibiting lavish windows, they effected the introduction of a monotone "grisaille" type of decoration, consisting mostly of leading on white glass (as at Angers, Chalons, and Salisbury) or of painted grisaille line ornament on white (as at Reims, Sens, St. Jean aux Bois). With increased use of line, the canopy and architectural details received more attention. The austerity of grisaille windows was sometimes relieved by a small colored medallion or, later in the early fifteenth century, by prominent use of colored glass on grisaille background, as at Exeter and York Minster in the famous "Five Sisters." The silver oxide tinting for yellowed effects lessened the severity of grisaille windows; and later, for example, when not only pattern work but figures were depicted on grisaille, golden aureoles and haloes appeared.

The Black Death of 1350 further modified window designs. This plague was of such dire proportions that it altered philosophic and religious attitudes of northern Europe and lessened the influence of the Church. No longer was the Church central and universal in its authority, and no longer were forms of art centrally dictated. Geographically interchangeable types, symbolic figures, ornaments, and signs were replaced gradually by actual landscapes, specific figures, contemporary costumes, and local plant forms. The Black Death had the effect of weakening faith in the hereafter and of strengthening interest in the immediate world and ordinary living. It also awakened a desire for isolation, regionalism, and security from intrusion. Although the subject matter remained predominantly religious, some secular windows were made featuring coats of arms and heraldic devices. The earliest heraldic shield devices are of the thirteenth century at Westminster Abbey and are forerunners of the later heraldic windows. For these, "flashing" is particularly important, for the details were too small to allow

contrasting solid glass with each change of color. The necessary minute coloring was accomplished by scratching away lines in the upper layer of flashed glass, revealing the different color beneath without recourse to leaded sections.

After the fourteenth century, sweeping generalizations about chronological design developments are made more by way of arbitrary convenience than strict analysis. With isolated regional activity and national schools, the rate of change was not uniform. There are, however, broad period ascriptions used by most art historians, and they are convenient for a cursory survey to indicate the general history.

The stained glass periods are usually defined as follows: of the earliest period, the eleventh- and twelfth-century windows at Augsburg and Le Mans have been mentioned, as has the early Gothic period at its height in the thirteenth century with notable examples at Chartres; the following Middle Gothic of the fourteenth century, in Germany called the "Geometric" period, in England the "Decorated," is marked by the increase in national differences and by line drawing; the later Gothic of the fourteenth century, in England called the "Perpendicular," in France the "Flamboyant," in Germany the "Interpenetrated," was decidedly regionalized and foreshadowed the Renaissance delight and pride in technical achievement.

After the mid-fifteenth century, rising humanism and individualism gradually affected the northern countries and culminated in the Renaissance. The spirit of anonymous dedication almost disappeared from glass making. Designers of windows were often known by name, signatures appeared, and patrons and donors were identified. Problems of perspective and "photographic" realism challenged the skill of the artists more than immaterial ideology.

Enamel painting came into use at this time. Sometimes this involved the scratching away of paint from a covered surface in an etching technique. The sixteenth-century windows were made with far greater pictorial freedom than before. Small domestic windows with genre scenes and landscapes became not uncommon. Until the middle of the seventeenth century these small windows were made in a combination of pot-metal, grisaille, and enamel, "as solid and permanent," according to Mr. Joep Nicholas, "as the all pot-metal medieval windows." St. Gudule in Brussels and Gouda in Holland have splendid windows from this period. Some seventeenth-century secular grisaille windows in England show imagination and humor and depict strolling players and comic figures as well as a feeling for the problems of domestic architecture.

After the middle of the seventeenth century, windows degenerated to mere paintings on glass, and the enamelled surfaces eventually cracked and peeled from weathering since the paint did not expand and contract with the glass. The small secular windows made by the Swiss are an exception, for on them the enamel did last admirably.

The eighteenth and early nineteenth centuries paid little attention to stained glass. During the second half of the nineteenth century, however, interest in imitating the earlier windows and designing modern ones in a romantic spirit revived in England with the pre-Raphaelites, with William Morris and most especially Burne-Jones, and in France with the ardent, antiquarian interest of Viollet-le-Duc. In the United States increasing wealth prompted the construction of many pseudo-Gothic churches with windows of varying quality. As communities expanded in America, churches were often erected in Gothic style with imitative glass work. In the more elaborate buildings, care was taken to have the inevitable stained glass windows designed to reproduce as closely as possible the fervor and jewellike effect of the great twelfth- and thirteenth-century masterpieces. John La Farge designed domestic windows executed by Tiffany, but these were not at all in the Gothic style, being more in the spirit of contemporary book illustrations. Connick, Saint, Heaton, and Joep Nicholas are notable among the great twentieth-century window designers; the last-named has designed several windows in modern form as well as great reproductions of the Gothic spirit. Since World War II the resurgence of religious feeling has stimulated an interest in church windows, some of which have been planned by modern painters and tapestry designers. In a new church at Assy, in the French Alps, stained glass windows are again an important architectural feature and have been designed by fifteen prominent French artists including Rouault, Lurçat, Leger, Arp, and Braque.

J. S. Ma.

**STAIRWAY, MOVING.** *See* MOVING STAIRWAY.

**STALACTITE AND STALAGMITE.** *See* DRIPSTONE; GEOLOGY (*Glossary of Geological Terms*).

**STALACTITE WORK.** *See* ARCHITECTURAL TERMS.

**STALIN, JOSEPH VISSARIONOVICH** [sta'lın] (1879-1953), leader of the Union of Soviet Socialist Republics and of the Communist Party from the death of Lenin in 1924 until his death in 1953, was born in the Caucasian village of Gori, Georgia, on Dec. 21, 1879. His mother was Ekaterina Georgievna and his father was Vissarion Ivanovich Dzhugashvili, a worker in a shoe factory in Tiflis. Stalin received his preliminary education in the Gori parochial school and in 1893 entered the seminary at Tiflis, an institution which had considerable influence upon him during his formative years. Clerical restrictions caused him to rebel, and by 1897 he was the leader of a Marxist group within the seminary. Communist-inspired literature says that Stalin was expelled from the seminary because of these activities, although this has been denied by his mother who insisted that she removed her son because of his poor health.

*JOSEPH STALIN*

SOVFOTO

After leaving the seminary, Stalin worked as a clerk in the Tiflis observatory, although his main interest in life was the Russian Social-Democratic Workers' Party, the Tiflis branch of which he joined in 1898. In this association he became a professional agitator, fostered mass strikes and demonstrations in Tiflis and Batum, and finally ran afoul of the police in 1902. He was arrested in Batum, where he spent a year in jail before being transferred to Kutaisi. In 1903 he was exiled to Siberia but later escaped and returned to Tiflis to resume his revolutionary activities.

While in Siberia, Stalin learned of the famed party split between the Mensheviks and the Bolsheviks and cast his lot with the latter. Stalin concerned himself almost entirely with the publication of underground revolutionary literature. His paper, *The Struggle for the Proletariat,* was, next to Lenin's, the most important Bolshevik periodical. In December 1905 Stalin attended the party conference at Tampere, Finland, where he met Lenin for the first time, thus beginning an association which eventually resulted in Stalin's inheritance of the leadership of the party after the death of Lenin. On June 26, 1907, Stalin organized and directed a robbery of the State Bank truck which was transporting funds from the railway station at Tiflis. This feat, which swelled the party funds by 340,000 rubles, brought about his arrest in Baku, where he served eight months in prison before being exiled to Solvychegodsk in the province of Vologda. While there, his wife, Katherine Svanidze, whom he had married in 1904, died of tuberculosis. Stalin subsequently, in 1919, married Nadezhda Alliluyeva (died 1932).

The period 1902-1917 was a tumultuous one for Stalin, consisting of a series of arrests (six), imprisonments, exiles, and escapes. Between times he was engaged in writing and publishing revolutionary literature. Following the March 1917 revolution he arrived in Petrograd, and with Leo Kamenev took charge of *Pravda,* the party's journalistic vehicle and still the official voice of the party. By this time he had completely dropped his real name of Dzhugashvili in favor of Stalin, which means "man of steel." In May 1917 Stalin was elected a member of the Politburo, the all-important governing body of the Soviet, and in 1922 was appointed by Lenin to the post of Secretary General of the Communist Party. During the civil war (1918-1920) he played an active role in gathering food and supplies for the Red army. He was particularly active in the Stalingrad area (then Tsaritsyn), and when that city was under fire of the White army he participated in its defense. It was during the civil war years that the breach between him and Trotsky, then Commissar of War, grew to serious proportions. He frequently disregarded and often countermanded Trotsky's directives. When Lenin died in 1924, Stalin formed a triumvirate with Zinoviev and Kamenev which successfully opposed Trotsky and his followers. Some mystery surrounds the finale of the relations between Lenin and Stalin, for the former is alleged to have left a last testament with his wife which said, among other things, "Stalin must be removed. He is too rude and this fault, supportable in relations among us Communists, becomes insufferable in the office of the Secretary General." Stalin, with the co-operation of Lenin's widow, is supposed to have suppressed this statement, although he did make reference to it some years later when his position had become secure. The last chapter in the contest between Stalin and Trotsky was written in 1927 when the latter attempted to convert the celebration of the anniversary of the revolution into a mass demonstration against Stalin. The attempt failed, and in December Trotsky and seventy-odd members of the opposition were expelled from the Communist Party. In January 1928 they were exiled. That same year Stalin inaugurated the first of the Five-Year Plans, a vast program of industrialization and collectivization which had as its purpose the placing of the Soviet on a firm economic basis. The Five-Year Plan was carried on despite the many hardships it wrought on the population and opposition from the rightist side of the Communist Party.

During the mid-1930's Stalin began to meet with serious resistance within the party. Then occurred the famous Moscow trials and equally famous purges. Such old comrades as Alexis Ryckov, Nicholas Bukharin, Gregory Zinoviev, and Leo Kamenev were placed on trial and eventually sentenced to death. The methods used to obtain confessions of betrayal, and the general air of inexorability which characterized the conduct of the trials, revealed to the outside world the nature of the Soviet dictatorship.

In August of 1939 Stalin surprised the world by engineering with Hitler the famous nonaggression pact between Germany and Russia. For the moment, the agreement was hailed as an instrument for peace and one that would contribute much to calming the troubled waters of Europe. But its true significance was revealed a month later when Stalin's Red army marched in and occupied one-half of Poland after that country's defeat by Germany. Further indications of Stalin's imperialism were brought to light by the Soviet attack on little Finland in November 1939 after that nation had refused certain territorial demands. On May 6, 1941, Stalin became the official head of the Soviet when he assumed chairmanship of the Council of People's Commissars (later named Council of Ministers). This event preceded by but a few weeks the break with Hitler and the Soviet Union's about face, which resulted in the invasion of the U.S.S.R. by the German army.

During World War II Stalin's leadership and iron will were credited with aiding in the defense of Moscow against the advancing Nazi armies and in their final defeat. He gained the title of Field Marshal on Mar. 7, 1943, and of Generalissimo on June 28, 1945. With President Roosevelt and Prime Minister Churchill he attended the Teheran Conference in 1943 and the Yalta meeting in 1945 and with President Truman and Churchill, the Potsdam meeting in 1945. After the war Stalin's attitude toward his former allies became inconsistent and unpredictable. He vacillated between protestations of friendship for the democracies and charges of imperialism. His policies seemed to be reflected in the Soviet conduct in Berlin and in its support of Communist China and North Korea.

Stalin's 29-year rule came to an end on Mar. 5, 1953, when it was officially announced in Moscow that he had died in the Kremlin at the age of 73 after being stricken with a brain hemorrhage four days earlier. F. W. P.

**STALIN.** *See* VARNA.

**STALINABAD** [stɑ'lɪnɑbɑ'd], the name of a region in the Tadzhik Soviet Socialist Republic of the Union of Soviet Socialist Republics, and of the capital of both the region and the Tadzhik S.S.R.

**The City.** Stalinabad, a manufacturing town and capital, is in the southernmost Soviet Union, about 130 mi. southeast of Samarkand and 92 mi. north of the Afghanistan frontier. It is located on a tributary of the Kafirnigan River, in an irrigated basin, at the southern foot of the Hissar Mountains. The modern city was built during the Soviet Five-Year Plans on the site of the old mud-hut village of Dyushambe. Its phenomenal growth brought a population increase of over 1,000 per cent from 1926 to 1939. Institutions include an institute of medicine and schools of agriculture and veterinary science. It lies on a branch of the Trans-Caspian Railway from Bukhara. Trade is in raw cotton, silk, fruit, lead, and arsenic. The principal manufacture is silk fabric. Pop. (est. 1950), 130,000. C. C. H.

**The Region.** The region of Stalinabad is bounded on the north by the Ura-Tyube Region, on the east by the Garm and Kulyab regions, on the south by the Kurgan-Tyube Region, and on the west by the Surkhan-Darya Region. Three

economic zones exist: the mountainous zone, the arid zone, and the irrigated valleys. Dominated by the Hissar Range, the western extension of the Alai Mountains which rise to elevations of more than 18,000 ft. above sea level, the first zone is a region of mountain pastures. The arid zone is a semidesert plateau, thinly populated by farmers who maintain limited herds. Economically the most important, and the most densely populated, the third zone comprises the valleys of the Vakhsh and of the Zeravshan rivers. Both are protected by the barrier of the Hissar Range from the cold winter winds that blow in from the Siberian lowlands. The Vakhsh Valley is outstanding for its production of long-staple Egyptian cotton. In the Zeravshan Valley the same crops that are to be found in the Samarkand section of the oasis appear: alfalfa, cotton, rice, sugar beets, vegetables, melons, mulberries, pistachio nuts, grapes, figs, barley, and a variety of temperate-zone fruits. Inhabiting the region are Tadzhiks, constituting 75 per cent of the total population, and Uzbeks. A network of new roads has been built leading to Tashkent, Leninabad, and Khorog. A railroad also connects Stalinabad with the Uzbek Soviet Socialist Republic.

W. S. V.

**STALINGRAD** [stʌlɪngra′t; stɑ′lɪngrad], the name of both a governmental region and the city that is the administrative seat of that region, located in the Russian Soviet Socialist Republic, in the southwestern Soviet Union.

### THE CITY

Stalingrad, formerly Tsaritsyn, is an industrial center on both banks of the small Tsaritsa River, about 380 mi. southeast of Kharkov. It is situated on a flat terrace on a high bank of the lower Volga River near its "elbow" at its closest approach to the Don River.

**History.** Although its actual date of origin is unknown, the city was first mentioned as a frontier fortress in 1589. A small town frequently attacked by marauding tribes during the sixteenth and seventeenth centuries, it was taken by the Cossack robber Stenka Razin in 1670 and was the scene of hostilities in the Pugachev Rebellion between 1773 and 1775. During the nineteenth century its importance increased as a transshipment point for goods shifted between the Don and the Volga, while railways further accelerated its growth. In the civil war from 1917 to 1920 the city was a key defense point against Krassnov's White Army attacks when Joseph Stalin personally directed the Red army's liberation of the city. In honor of Stalin's strategic leadership during the liberation, Tsaritsyn was renamed Stalingrad in 1925. During the First and Second Five-Year Plans, industries developed rapidly, and the population increased nearly 300 per cent by 1939.

**Battle of Stalingrad.** The city's fame became universal after the Soviet army's heroic defense against the Nazis in World War II. The German plan was to cut the vital supply artery of the Volga at its westernmost point; success in such an operation would have been a crucial blow to Russian defenses, whether at Stalingrad or elsewhere along the Volga. Fully realizing the strategic necessity of retaining the city, Russian commanders met the first attack in August 1942 with unprecedented stubborn defense. Nazi bombs and artillery leveled the town, and German troops finally reached the center of the city; but Soviet troops held Mamai Kurgan Hill, overlooking the city, and no German troops crossed the Volga. In January 1943 the Red army turned the tide, repulsed the Germans, and by February 2 had freed the city, capturing 330,000 Nazi troops. The Battle of Stalingrad, one of the fiercest in history, marked the beginning of the decline of German military power in the war and is one of the great turning points in military history. The intense house-to-house fighting left virtually nothing intact in the city; all buildings were destroyed and factories wrecked.

**Streets and Buildings.** Reconstruction began in 1943 and had made considerable progress by 1950. Twenty thousand carloads of debris were moved out of Stalingrad in a five-year period. Of interest is the Square of the Fallen Heroes, in the center of the city, dedicated to the defenders of 1919 and 1920. Institutes of agriculture, medicine, mechanics, and pedagogy are also located in Stalingrad.

**Commerce and Industry.** As the economic and industrial center of the lower Volga, Stalingrad contains many large industrial establishments, especially the Red October Steel Plant and a huge tractor factory, both destroyed in the war but restored afterward. There are also oil refineries, sawmills, wood-working plants, shipbuilding yards, grain mills and elevators, and chemical, clothing, canning, and leather factories. There is a large port on the Volga, and goods are transshipped either on the Don River or by long-distance rail lines which focus on Stalingrad. Pop. (est. 1954), 450,000.

C. C. H.

### THE REGION

The Stalingrad Oblast (Region) is contiguous to the Voronezh and Saratov oblasts on the north, the West Kazakhstan Oblast on the east, the Astrakhan Oblast on the south, and the Rostov Oblast on the south and west. With an area of 52,264 sq. mi., it slopes from the pre-Volga Heights in the northwest to the low Ergeni Hills in the south. Deflection, caused by rotation of the earth, has caused the Volga River to cut into the heights, already a strongly dissected plateau, thus creating an extremely steep western bank. Along the eastern side of the river stretches fairly flat terrain. Between the heights and the Ergeni Hills is a low depression, undoubtedly at some time in the past the former channel of the Volga River. At this point the Volga and the Don rivers are separated by only 60 mi. The Volga-Don Canal, completed in 1952, bridges the gap and provides the city of Stalingrad, located at the depression, with a water-route to the Black Sea in addition to its connection with the Caspian Sea.

Steppe conditions prevail throughout the Stalingrad Region as a result of precipitation which averages 14 in. annually, but often falls far below that amount. The region suffered a great drought and famine in 1921. However, more moisture occurs on the pre-Volga Plateau than on the plains to the east of the river, since the high western bank acts as a barrier to the moisture-bringing westerly winds. For this reason, and because of the fertility of the chestnut-brown plateau soils, the inhabitants engage in agriculture and cattle raising on the plateau and sheep grazing on the eastern plains, where the camel is the principal beast of burden. Spring wheat, sunflower seed, mustard seed, grapes, winter rye, oats, and spring barley are the chief crops. A strip of rich, alluvial land on either side of the river is tilled also, producing cotton and vegetables. Fishing, tanning, and textile making are other occupations of the peasants. In the eastern section are lakes which produce salt. In spite of the small number of industrial centers, the region is relatively thickly populated. Pop. (est. 1954), 1,500,000.

W. S. V.

**STALINO** [sta′lɪnə], the name of both a governmental region and the city which is the administrative center of that region, located in the southeastern Ukrainian Soviet Socialist Republic, in the southwestern Soviet Union.

**The City.** The city is an industrial community about 105 mi. northwest of Rostov. Stalino was founded in 1872 as Hughesovka or Yuzovka by a Welshman named Hughes, who had been granted a concession by the Russian government to manufacture iron rails. Its population increased 250 per cent under Soviet Five-Year Plans. Captured by the Nazis on Oct. 21, 1941, it was retaken by Soviet troops on Sept. 8, 1943; the city was almost destroyed in the fighting. Points of interest, many of which were destroyed or damaged in World War II, included the industrial institute of the Donets, the House of the Soviets, an opera house, three colleges, several theatres, and a large municipal park. As the oldest steel-manufacturing town and the main metallurgical center of the region, it is considered the "capital" of the Donets Basin ("Donbas"). One of the most rapidly developing Soviet industrial cities, it has many coke ovens, blast furnaces, and steel works. It uses Donets Basin coal, iron from Krivoi Rog and Crimea, and nearby limestone, dolomite, and fire clay. Pop. (est. 1954), 600,000. C. C. H.

**The Region.** Stalino Oblast (Region), an administrative unit of the Ukrainian Soviet Socialist Republic, touches on the north coast of the Sea of Azov. The region is bounded by the Zaporozhye Oblast on the west, the Dnepropetrovsk Oblast on the northwest and north, the Kharkov Oblast on the north, the Voroshilovgrad Oblast on the east, and the Rostov Oblast on the southeast, while the Sea of Azov forms the entire southern boundary. Makeyevka, the so-called Ukrainian Magnitogorsk, is only about 12 mi. northeast of Stalino. Another important city is Zhdanov, or Mariupol, a port on the Sea of Azov, which exports principally coal and ore. Pop. (est. 1954), 3,900,000. W. S. V.

**STALINOGORSK** [stʌlinɑgɔ'rsk], formerly Bobriki, an industrial city in the Moscow Region of the Russian Soviet Federated Socialist Republic, in the southwestern Soviet Union, 128 miles south of Moscow. It lies on a slope on the small Skhot River, a tributary of the Upa. Formerly an obscure village, the industrial city has developed since 1928 under the Soviet Five-Year Plans. Captured by the Germans on Nov. 26, 1941, it was recaptured shortly afterward by the Soviet forces. It is on a rail line from Moscow. It has chemical plants producing nitrogenous and phosphatic fertilizers, using local deposits of brown coal and phosphates. It also has an important electric power station, utilizing the brown coal of the area. Pop. (est. 1950), 125,000.
C. C. H.

**STALINSK** [sta'lɪnsk], formerly Kuznetsk, an industrial city in the Kemerovo Region of the Russian Soviet Federated Socialist Republic, in the south central Soviet Union, about 190 mi. southeast of Novosibirsk. It lies in a broad valley, at the confluence of the Tom and Kondoma rivers, in the hilly Kuznetsk coal area. The fort of Kuznetsk was established in 1618, but remained a small village even after coal mining began two centuries later. Because of the vast coal resources, a great steel mill was built at Stalinsk during the Five-Year Plans, and there was an intensification of coal and iron-ore mining in the area. From 1926 to 1939 the population increased over 4,000 per cent. A branch railway connects Stalinsk with the Trans-Siberian, and the Tom River is navigable below the city. The steel mill is one of the largest and most modern in the world and is the principal industry. Pop. (est. 1950), 275,000. C. C. H.

**STAMFORD,** a city in Fairfield Co., Conn., situated on Long Island Sound, 38 mi. southwest of New Haven and 33 mi. northeast of New York City. Stamford was settled in 1641 by a colony from New Haven on the site of an Indian village. It was incorporated as a borough in 1830 and as a city in 1894. The city's government is by a mayor and board of selectmen. Within Stamford, as well as in the surrounding area, are numerous small parks. Cumings Park, the largest, with approximately 95 acres, is situated on Long Island Sound and has 1,600 ft. of beach. The municipal yacht basin, which is located in the park, provides a safe harbor for scores of motor boats and yachts. Stamford, situated on the fringe of the metropolitan area, is a popular home for many people working in New York City. Shippan Point is one of the city's several beautiful residential districts. Commuter service and freight facilities are supplied by the New York, New Haven and Hartford Railroad. A major industrial center, Stamford has factories producing roller bearings, castings, chemicals, cosmetics, electrical appliances, lacquers, machinery, oil burners, precision instruments, plastics, rubber products, stoves, hardware, locks and tools. Pop. 1950, 74,293.

**STAMMERING.** *See* STUTTERING.

**STAMP, BARON JOSIAH CHARLES** (1880-1941), British economist and banker, was born in Bexley, Kent, June 21, 1880. At the age of sixteen he began his career as a clerk in the British inland revenue service, where he remained for 23 years, becoming one of the government's foremost tax experts. While still a clerk he studied at the University of London. At the outbreak of World War I he was elevated to an assistant secretaryship in the British Treasury, where his service proved so valuable that before the end of the war he had become chief financial adviser to Prime Minister David Lloyd George. In 1919 Stamp entered private business as managing director of a large chemical firm, meanwhile lecturing at various universities on economic and statistical subjects. He sat on a number of government commissions and had considerable influence on the British tax structure, a service for which he was knighted in 1922. In 1924 he was British representative on the German reparations commission in Paris which produced the Dawes Plan, and in a similar capacity five years later he helped draw up the Young Plan. He was a director of the Bank of England, and when World War II began he became chief economic adviser to the British wartime cabinet. He, his wife, and his eldest son were killed Apr. 16, 1941, in a German air raid on London.

Stamp wrote extensively. Among his best-known works are *British Incomes and Property* (1915), a statistical study of capital and income; *Fundamental Principles of Taxation* (1919); and *Wealth and Taxable Capacity* (1922). E. W.

**STAMP ACT OF 1765.** After the French and Indian War, the British government left about 10,000 soldiers permanently in the American colonies to defend the frontiers against the Indians, to assist in the enforcement of the acts of trade and navigation, and to police Americans generally. Since the costs of British government were much increased, it was decided to place part of the burden of supporting the troops on the Americans. It was announced that a stamp tax would be imposed on Americans unless they offered some other acceptable plan as a substitute. Since nothing satisfactory was proposed, the Stamp Tax was enacted by the British Parliament in 1765. It provided that all colonial newspapers, legal documents, and business papers must be stamped, the stamps to be paid for in specie. The proceeds would be spent in America to support the troops.

The Stamp Tax irritated two vocal and influential groups of Americans: the lawyers and the newspaper editors. The first important public opposition came from the Virginia legislature, which adopted a set of resolutions stating that only the Virginia legislature could tax Virginians, and that to give such power to any other legislature would be to destroy American freedom. Patrick Henry, a member of the Virginia legislature, urged adoption of the resolutions in a speech in which he said: "Caesar had his Brutus, Charles the First his Cromwell and George the Third may profit by their example. If this be treason, make the most of it." In the North many merchants agreed not to buy British goods until the act was repealed. Town meetings denounced it and renewed the cry of no taxation without representation. Then, on the call of Massachusetts, it was agreed to hold an intercolonial Congress (Stamp Act Congress). Meanwhile rioting took place in towns where the stamps were to be sold. In Boston, the political enemies of Thomas Hutchinson, the governor, wrecked his house. In New York, mobs attacked the houses of British officials. Everywhere men who had been appointed stamp salesmen were forced to resign. The result of these various actions and of the pressure of British merchants on Parliament was the repeal of the Stamp Act in 1766. M. Je.

**STAMP COLLECTING.** *See* PHILATELY.

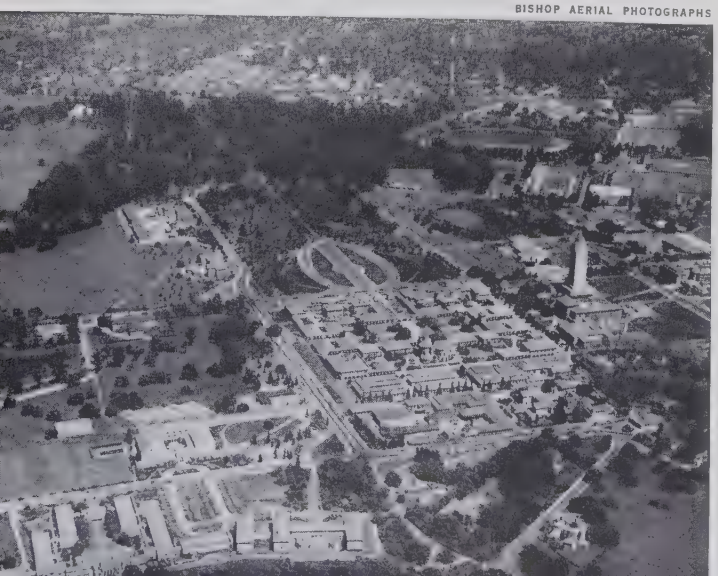
**STANDARDS OF MEASUREMENT.** *See* MEASUREMENTS, STANDARDS AND UNITS OF.

**STANDARD TIME.** *See* TIME.

**STANDISH, MYLES** or **MILES** (c.1584-1656), Pilgrim captain and Plymouth colonist, was born in Lancashire, England, about 1584. After serving in Queen Elizabeth's army in the Netherlands he joined the first company of the *Mayflower,* which landed at Plymouth, Mass., in 1620. He was appointed captain and became the colonists' mainstay in his friendly relations with the Indians, at times preventing Indian massacres and rebellions. In 1625, Standish was sent to England as an agent for the Pilgrims to negotiate with the Council for New England on supplies and the Pilgrims' rights in the new Plymouth Colony. He was fairly successful in his mission, returning in April 1626. In 1630 he became attorney for the Council for New England to aid the colonists in obtaining their lands under the new grant. In 1631 Standish and John Alden founded Duxbury, Mass., where he died on Oct. 3, 1656, at his estate "Captain's Hill." One of Standish's sons married a daughter of John Alden, the envoy in H. W. Longfellow's *Courtship of Miles Standish.* Standish, a brave soldier of great physical endurance, lived to see the population of Plymouth Colony grow to over 8,000. W. E. A.

*Air view of the campus at California's Stanford University. At the right center is the main quadrangle of university buildings; in the background the city of Palo Alto.*

BISHOP AERIAL PHOTOGRAPHS



**STANFORD, LELAND** (1824-1893), American railroad builder, governor, senator, and philanthropist, was born in Watervliet, N. Y., March 9, 1824. He was educated in the local schools, read law, was admitted to the bar in 1848, and began practice in Port Washington, Wis. Because of the loss of his law office and library by fire in 1852, Stanford moved to California, where several of his brothers were already established, and with their help engaged successfully in business. He was drawn to politics, became widely known in California, and was elected governor in 1861, serving until 1863. He then devoted his entire time to railroad construction and was president of the Central Pacific Railroad from 1861 until his death. On May 10, 1869, at Promontory Point, he drove in the gold spike joining the Central Pacific with the Union Pacific. He opposed public control of or interference with private railroad operations. Stanford was elected to the United States Senate in 1884, serving from March 1885 until his death. Aside from his business and political interests, he maintained extensive vineyards in Tehama County, Cal., and established a large ranch at Palo Alto where he bred and ran fine racing stock. His interest in education, and the untimely death of his son in 1884 at the age of fifteen, caused him to establish and endow Leland Stanford, Jr., University as a memorial. Stanford died in Palo Alto, Cal., June 21, 1893. T. R. H.

**STANFORD UNIVERSITY,** an accredited, coeducational, privately controlled institution. It is located on a campus of 1,500 acres at Stanford, Calif., in the Santa Clara Valley, 30 mi. southeast of San Francisco and 1 mi. from Palo Alto. Founded in 1885 as the Leland Stanford Junior University (still the legal name), the name has been shortened for all general purposes to Stanford University since about 1916. First instruction was given in 1891. The numerous divisions were founded as follows: School of Law, 1893; School of Medicine and School of Nursing, 1908; School of Education, 1917; Food Research Institute, 1921; School of Biological Sciences, 1922; Graduate School of Business, 1925; School of Engineering, 1925; School of Physical Sciences, 1926; School of Social Sciences, 1926; School of Humanities, 1941; Department of Physical Education and Athletics, 1945; and School of Mineral Sciences, 1947. The local chapter of Phi Beta Kappa was organized in 1904.

Degrees offered include the A.B. in liberal arts and the B.S. in engineering and in various types of engineering study. Professional and graduate degrees include the M.A., the M.S., the Ph.D., the M.B.A., the M.Ed., the D.Ed., the LL.B., the LL.M., and the M.D. Recently organized is the Stanford Research Institute, a nonprofit development established to provide, equip, and maintain laboratories and other experimental facilities for scientific and industrial research and to make them available to Stanford and other institutions and organizations for conduct of research and investigations. A Pacific-Asiatic-Russian studies program has been initiated by the School of Humanities, aided by a Rockefeller five-year grant and the action of the non-Communist Chinese government in providing a number of scholarships for American

students studying Chinese culture. A series of undergraduate regional majors has been established in the School of Humanities, covering Central Europe, France, and the Pacific-Asiatic-Russian areas. The library has available nearly one million volumes. Among the special collections featured are the Cubberley Library on Education; the Charlotte Ashley Felton Memorial Library of English and American literature; the Graduate School of Business Library; the Hoover Library on War, Revolution, and Peace; the Hopkins Transportation Library; and the Lane Medical Library. Collections dealing with Australia, Brazil, Greenland, and the French Revolution are of special interest. There is some scholarship aid offered and funds are available for student loans. Substantial fellowships in speech and drama have been established within recent years. Undergraduate women from outside the city who are not living with parents or guardians must live in the residence halls. Lower division men not living at home or working for their rooms elsewhere are required to live in residence halls for one year. Living quarters are also available at some of the fraternity houses. There are no sororities on the campus. *For statistics see* COLLEGES AND UNIVERSITIES. J. R. To.

**STANISLAVSKY** [stanisla'fsk3i], stage name of Konstantin Sergeyevich Alexeyev (1863-1938), Russian actor and producer, was born Jan. 17, 1863, in Moscow. Stanislavsky was a great actor and stage manager, the creator of a system of dramatic instruction based on natural laws of emotional, spiritual, and physical reactions, and founder, with V. I. Nemirovich-Danchenko, of the famous Moscow Art Theatre. His maternal grandmother was a French actress; his father, a wealthy Moscow industrialist of peasant antecedents, encouraged his children's musical and dramatic interests by building a private theatre in his home. Stanislavsky was a founder of the Society of Art and Literature, where he acted in and directed plays until the establishment of the Moscow Art Theatre (1898). A student of the principles of acting in Russia and abroad, especially in the practices of Shchepkin, Salvini, and the Meiningen Theatre, he evolved his own system of preparing plays and parts, which resulted in remarkable ensemble acting. He applied his acting principles to grand opera in his Opera Studio and School; moreover, he established three studios in the Moscow Art Theatre and set up other independent theatres, among them the Habbima Jewish Theatre. As an actor he created many notable roles in classic and modern plays. His hospitality to new ideas drew many distinguished foreign artists to the Art Theatre, such as Gordon Craig, who designed a production of *Hamlet,* and Alexander Moissi. Stanislavsky's ideas, recorded in two books, *My Life in Art* (1924) and *An Actor Prepares* (1937), have deeply influenced artists in many fields and countries. He died Aug. 7, 1938, in Moscow. *See also* RUSSIAN DRAMA (*Moscow Art Theatre*). E. R. H.

**STANLEY, SIR HENRY MORTON** (1841-1904), British explorer, was born at Denbigh, Wales, June 29, 1841, as John Rowlands. He was orphaned at the age of three, and at eighteen shipped as a cabin boy to New Orleans, where he was befriended by a merchant, Henry M. Stanley, whose name he adopted. He enlisted in the Confederate Army in 1861 and was captured at the Battle of Shiloh. In 1864 he enlisted in the Union Navy. As a newspaper correspondent he covered the Indian campaign of 1867, and in 1868 the New York *Herald* sent him with the British military expedition to Abyssinia. In 1869 he was commissioned by the *Herald's* proprietor, James Gordon Bennett, to search for the African explorer, David Livingstone. Starting out in March 1871, Stanley finally discovered the ailing Livingstone at Ujiji on Lake Tanganyika and nursed him back to health. In 1874 Stanley reported the British campaign against the Ashantis and then, taking up African exploration, made a survey of the shores of Victoria Nyanza and discovered the Kagera River, the most remote headstream of the Congo.

*SIR HENRY MORTON STANLEY*

COURTESY OF THE AMERICAN MUSEUM OF NATURAL HISTORY

In 1876 he descended the Congo River, from Nyangwe on the Lualaba River, crossed the Equator, and reached Boma at the mouth of the Congo in 1877. Between 1879 and 1884 he founded trading stations for King Leopold II of Belgium from Vivi to Stanley Falls on the Congo River, acquiring treaty rights from native chiefs to build roads through the cataract country. This exploration led to Belgian sovereignty over the Congo Free State. In 1888, he commanded an expedition for the relief of Emin Pasha, governor of the Egyptian Sudan. He discovered Mount Ruwenzori and traced the Semliki River to its source in Lake Edward in 1889. A repatriated British subject, Stanley entered Parliament in 1895 as a Liberal Unionist. He was the author of several accounts of his travels as well as of a study of the slavery problem. He died in London, May 10, 1904.

S. Van V.

**STANOVOI MOUNTAINS.** *See* DZHUGDZHUR.

**STANTON, EDWIN McMASTERS** (1814-1869), American lawyer and secretary of war, was born Dec. 19, 1814, at Steubenville, Ohio. His early education was interrupted by the death of his father in 1827, but he was admitted to Kenyon College, Ohio, in 1831. Spending only two years at Kenyon, he began to study law and was admitted to the bar in 1836. He was prosecuting attorney of Harrison County, Ohio, from 1837 to 1839. Stanton moved to Pittsburgh in 1847 and to Washington, D.C., in 1856. He remained both a Democrat and a Free-Soiler. In 1858 he was special counsel for the United States in cases involving land grants made by the Mexican government before the Mexican War. On Dec. 20, 1860, the date on which South Carolina seceded from the Union, Stanton became attorney-general of the United States under President James Buchanan. A strong Unionist, yet a Democrat, Stanton cooperated with Charles Sumner and W. H. Seward in exposing subversive activities, for which he was accused of betraying Buchanan. In 1861 he became legal adviser to President Abraham Lincoln's secretary of war, Simon Cameron, and on Jan. 20, 1862, himself became secretary of war, which office he filled with facility, although he had disputes

with Generals G. B. McClellan and U. S. Grant of the Union Army.

After Lincoln's assassination, President Andrew Johnson retained Stanton as secretary of war. Disagreeing with Johnson's policy of presidential control of Reconstruction, Stanton was asked by Johnson to resign his office, but Stanton, protected by the Tenure of Office Act, refused. Nevertheless, the failure of President Johnson's impeachment caused Stanton to resign on May 26, 1868. On Dec. 20, 1869, under President U. S. Grant, Stanton was appointed an associate justice of the United States Supreme Court, but he died on Dec. 24, 1869, in Washington, D.C. before he could take his seat. A Jacksonian Democrat, Stanton changed the policy of his party with his federalist convictions. He was an able administrator whose patriotic efforts were in large part responsible for the Union victory.

W. E. A.

**STAR, MORNING AND EVENING,** an expression applied only to the planets Mercury, Venus, Mars, Jupiter, and Saturn. A planet in this group is typically in the position of morning star when observable in the eastern sky before sunrise, and in the position of evening star when in the western sky after sunset. Strictly applied, Mercury or Venus is morning star from inferior conjunction to superior conjunction with the sun, and evening star from superior conjunction to inferior conjunction. Mars, Jupiter, and Saturn are morning stars from conjunction to opposition with the sun, and evening stars from opposition to conjunction.

H. S. R.

**STAR APPLE,** a tropical American tree, *Chrysophyllum cainito,* of the sapodilla family, widely cultivated in warm regions, both ornamentally and for its edible fruit. It is an evergreen reaching a height of 50 ft. The tree has oblong leaves, shiny above and covered below with a silky, golden-brown down. It bears purplish-white flowers. The smooth, globular, purple or light green fruit, as much as 4 in. in diameter, has 3 to 8 shiny seeds; in cross section, the core makes a star-shaped figure against the translucent white pulp.

J. C. Wis.

**STARA ZAGORA** [stɑ′rɑ zɑgɔ′rɑ], a city about 50 mi. northeast of Plovdiv in central Bulgaria at the southeastern edge of the Balkan Mountains. It is the capital of Stara-Zagora County. After the Russo-Turkish War of 1877-1878, in which the city was almost completely destroyed, it was rebuilt along modern lines. Some of Bulgaria's numerous mineral springs are found near the city, which is the market center for a productive agricultural area. The region is noted for its production of attar of roses. Under Turkish rule, it was important for its coarse woolen cloth, much of which was used by the Turkish army. Present products include vegetable oils, beer, and other beverages, food products, furniture, earthenware, and tanned leather. The city is an important railway junction for the Plovdiv-Burgas Railway and the line from Ruse or Ruschuk. Pop. 1946, 37,057.

E. St.

**STARCH,** a carbohydrate abundantly distributed throughout the plant kingdom. Its chemical formula is $(C_6H_{10}O_5)_n$, where $n$ is a large number, 500 or more.

**Sources.** Life, as we know it, could not exist without starch. It is the primary reservoir of solar energy, being produced in leaves from carbon dioxide by the aid of chlorophyll, and stored in roots, tubers, and seeds. Animal life derives a large portion of its food from the starch thus stored by vegetation. Potatoes and the cereal grains comprise an overwhelmingly large proportion of the food of the human race. Starch occurs in plants as small individual particles or grains, easily visible under low-power magnification. The starch from each species of cereal or tuber has a characteristic appearance or shape, the root-starch particles in general being larger than those of the grains. The principle sources of industrial starch are white potatoes in Europe and Indian corn in the United States. Other important sources of starch are sweet potatoes, cassava, wheat, and rice.

**Structure.** Experimental difficulties encountered in the study of carbohydrate polymers are responsible for a lack of definite knowledge concerning the structure of the starch molecule. However, persistent research has led to the view that starch is composed of two substances, both polymers of glucose. These components of starch have been called by various names, amylose and amylopectin or alpha-amylose and beta-amylose, and different investigators have reported wide variations in the relative amounts of each. One fraction, amylose, gives an intense blue color with iodine, a high yield of maltose on hydrolysis with beta-amylase, and has a marked tendency to retrograde. Its molecule is considered to be a long, unbranched chain consisting of from 100 to 300 *d*-glucopyranoside units connected by 1:4 alpha glucosidic linkages. The other component, amylopectin, gives a purple color with iodine and yields only about 60 per cent maltose on hydrolysis with beta-amylase, the remainder of the hydrolytic material being the so-called limit dextrins. This starch fraction is considered to have a more ramified or branching structure. Strong evidence has been advanced to show that this fraction of starch consists of units of 24 to 30 *d*-glucopyranoside residues connected by the normal 1:4 alpha-glucosidic linkages, while these units, in turn, are connected through 1:6 glucosidic linkages. The molecular weight of starch is in the order of magnitude of 100,000 or more. In the starch granule, however, it is clear that there must be many molecules held together by some little-understood chemical force.

**Properties and Types.** All starches are insoluble in cold water; but on heating, the grains swell and burst, forming a jelly, paste, or viscous liquid. It is to this property that many of the important industrial uses of starch are due, especially its use as an adhesive, and for sizing textile fibers and paper. Dry or acidified starch is converted into dextrin by roasting. When heated in water with acid, starch undergoes a series of changes, depending upon the amount of acid, temperature, and time of treatment. Mild heating with dilute acid causes no visible change in the microscopic appearance of the starch grains, but pastes subsequently made from this treated starch are of low viscosity. Such starch is called "thin-boiling" and finds much favor in the textile industry. Treatment in water at a higher temperature with a somewhat larger proportion of acid produces a dextrin paste, whereas more drastic treatment at a still higher temperature, usually under pressure, causes the starch to dissolve completely, forming a sweet-tasting, thin liquid, the dissolved material consisting of about equal parts of dextrin and sugars. When this liquor is refined and evaporated, a widely used product, known as confectioners' glucose or corn sirup, is obtained. When the amount of added acid is further increased and the pressure heating is prolonged, a still sweeter liquor is produced, which after refining and concentration results in a magma from which crystalline dextrose or corn sugar is obtained. Amylases, or starch-splitting enzymes, convert a starch paste into the soluble products, dextrin and the sugar, maltose. This reaction is

the basis of the grain-alcohol fermentation industry, where the source of the amylase is usually barley malt or a fungus grown on bran. The resulting maltose is then fermented by yeast or ethyl alcohol and carbon dioxide. A combination of mild acid liquefaction of starch followed by enzyme hydrolysis is employed to produce a type of corn sirup called sweetose, which contains less dextrin and more sugar and hence is sweeter than the older, standard type of corn sirup.

**Derivatives.** Starch can be readily oxidized. Mild oxidation with sodium hypochlorite produces a modified starch which forms a transparent paste and is widely used for paper sizing. More drastic oxidation, as with strong nitric acid, completely breaks down the molecule, forming saccharic acid, oxalic acid, carbon dioxide, and others. Starch may be nitrated to form nitrostarch, an explosive. Starch esters and ethers may readily be produced. These derivatives can be used for protective coatings or plastics but have found little industrial application.

**Uses.** In addition to its food value and its extensive employment in the manufacture of sirups and sugar, starch has an almost unbelievable number of uses in the industrial field. It is a raw product for the manufacture of alcohol, acetone, butanol, lactic acid, and other products of fermentation. The textile and paper industries consume great quantities of starch. Special laundry starches are a volume market, and other uses cover the field from cosmetics to explosives. J. K. D.

**STAR CHAMBER, COURT OF.** *See* ENGLAND AND WALES (*History*).

**STARFISH,** called also sea star, a common marine animal belonging to the class Asteroidea of the echinoderms, having no relationship or resemblance to fish. The sea stars are characterized by their five-rayed form and warty or spiny surface. They consist of a central disk from which radiate five arms broadly attached to the disk. Some sea stars have more than five arms, up to twenty or more, but five is the usual number. The body has distinct lower or oral, and upper or aboral, surfaces. The upper surface is usually provided with calcareous tubercles and short spines that are articulated to internal calcareous pieces, and it also has, in the angle between two of the rays, a small round perforated plate, the madreporite, through which water is admitted to the water-vascular system. The minute anus is in the center of the aboral surface. The oral surface, on which the animal creeps, has a central mouth from which radiate five grooves, one in each arm. In these grooves are the tube feet by which the animal moves. These feet are flexible tubular projections having terminal suckers, and are operated by water pressure conveyed in a system of canals; the whole mechanism is termed the water-vascular system. The digestive system is interesting. There are two superimposed stomach sacs in the disk; from the upper or pyloric sac radiate ten voluminous digestive glands, two in each arm. The food of common sea stars consists of various other animals, especially oysters and other bivalves. The sea star folds its arms over the bivalve, attaches its tube feet to the shells, and by exerting a pull, and probably by pouring out digestive secretions opens the victim. The lower stomach is everted into the oyster's shell, and digestion takes place by the secretions of the glands. The pabulum so obtained is taken into the interior, and as there is little need for further digestion, the intestinal part of the digestive tract is greatly reduced. Because sea stars are highly destructive to oyster beds, many efforts have been made to eradicate them, but no satisfactory method has been found. If sea stars are torn apart and thrown back in the water, they simply regenerate. Any part that includes a good piece of the disk is able to regenerate a new star. Sea stars reproduce by shedding eggs and sperm into the sea water. A free-swimming larva results that undergoes a process of metamorphosis in becoming a tiny sea star, which requires several years to grow to adult size. *See also* ECHINODERM. L. H. Hy.

COURTESY OF THE NEW YORK ZOOLOGICAL SOCIETY

*The common starfish, Asterias forbesi, a marine animal, usually five-armed, which feeds on clams and oysters*

**STARGAZER,** *Astroscopus guttatus,* a small, robust fish of the family Uranoscopidae with eyes located on top of the head. The head is large with an upturned mouth that is bordered by fringed lips. The stargazer lurks quietly on or partly buried in sand awaiting its prey. Capable of giving an electric shock, it is called, in some places, "electric toad." The electric organs are located in two quadrate-shaped areas that lie behind the eyes. A 6-in. fish gives a very noticeable shock. It perhaps serves as a protection from enemies and shocks small crustaceans and fishes upon which it feeds. A length of about 12 in. is average. About 15 species of this family are known from tropical and temperate seas. Some of the larger kinds are caught commercially as food. E. C. R.

**STAR GRASS,** *Hypoxis hirsuta,* a small herbaceous perennial of the amaryllis family having grasslike leaves. The 6-pointed, starlike, yellow flowers, greenish and hairy on the outside, bloom in groups of 1 to 6 and are lower than the tips of the leaves. A native of meadows and open woods from Kansas northward to Canada and eastward to the Atlantic, star grass can be grown in any rock or wild garden which is moist and partly shaded. J. C. Wis.

**STARK, JOHANNES** (1874- ), German physicist, was born in Schickenhof, Bavaria, on Apr. 15, 1874. He was named assistant at the University of Göttingen in 1900, taught in Hannover (1906-1909) and in Aachen (1909-1917), and was a professor at the University of Greifswald (1917-1920) and at Würzburg (1920-1921). He then retired and for many years did only occasional private teaching. In 1933 he was appointed president of the Physico-Technical Institute and of the German Research Association.

In 1905 Stark observed a Doppler effect in canal rays, for which he received the Baumgartner Prize of the Vienna Academy. In 1913 he discovered that spectral lines split under the influence of an electric field, a phenomenon analogous to the splitting of these lines in an electric field which Zeeman

observed in 1896. This discovery provided one of the clearest and strongest confirmations of the quantum theory of matter. For this work he was awarded the Nobel Prize in 1919. Cleavage in a magnetic field is now called the Stark effect.

Among Stark's many important technical books are *Electricity in Gases* (1902), *Principles of Atom Dynamics* (1910), and *Variations in the Structure and Spectrum of Chemical Atoms* (1920). He also founded the *Yearbook of Radioactivity and Electronics* which he edited from 1904 to 1919. After World War II Stark lived in Bavaria, in the United States zone of Germany. S. M. M.

**STARLING,** any one of a large number of species of medium-sized songbirds that together form the family Sturnidae. They are widely distributed in the temperate and tropical regions of the Old World, and one, the 8-in. *Sturnus vulgaris,* has been artificially introduced into the United States, where it has become abundant. The typical starlings

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*A starling carrying a may beetle to her young*

are characterized by a stout body, strong bill and feet, long, pointed wings, and a short tail. Their plumage may combine such dull colors as black, white, grays, and browns, or metallic blues, greens, and violets. Many species thrive best around human settlements. Almost all breed in holes in trees or in protected house areas, and during the rest of the year travel in flocks. They feed on insects, fruits, and grains. Their notes are loud and often melodious. Some species, especially the Asiatic grackles, are famous for their ability to imitate the human voice. H. G. De.

**STAR-OF-BETHLEHEM,** a genus, *Ornithogalum,* of the lily family having many species widely scattered in the Old World. These plants are bulbous perennials, reaching a height of 10 ft. Several tender species from South Africa are cultivated by florists. The name is especially used for *O. umbellatum,* a native of the Mediterranean region widely naturalized from old gardens. It has grasslike, basal leaves, and a slender flower stalk growing as high as 1 ft., which, in spring, bears clusters of starlike, white flowers striped with green, opening only in full sunshine.

J. C. Wis.

**STARS,** distant suns appearing as points of light on the night sky. Actually stars are immense spheres of incandescent gas existing in the depths of space in untold numbers and situated at unthinkable distances. They are cosmic powerhouses radiating prodigious energy. The sun is a star much like millions of others; but its comparative nearness to the earth causes it to seem large and almost blinding to the eye. Stars do not appear scattered evenly over the heavens, but are arranged in groups (constellations). These seem to preserve always the same configurations; yet the stars are really all in motion. Although the stars look as if placed on a great concave surface—the celestial sphere—they actually exist in a three- or four-dimensional universe; that is, they are at varying distances away, some comparatively near and others farther off by many light-years. Stars should not be confused with planets. At first glance, they cannot always be told apart; yet the planets move, day by day, on the sky. And they are other worlds like the earth, while the stars are hot, self-luminous bodies.

The extremes manifested in the stars are surprising, even though they are of the same basic pattern. The intrinsic brightness of certain stars turns out to be billions of times that of the faintest stars. The surface temperature range is from approximately 1,600° C., for "cool" stars, to a temperature of possibly 50,000° C. Stellar volumes and densities likewise present very excessive extremes, but the masses do not.

**Constellation, Atlases, and Catalogs.** The entire sky is divided into 89 sections, the area of each section comprising a constellation in the modern meaning of the term. There are north circumpolar, equatorial, and south circumpolar constellations, according to the observer's latitude. Around the ecliptic, there are 12 zodiacal constellations, which have been important historically and which have given their names to the 12 signs of the zodiac used in astrology. They are (in order eastward from the vernal equinox) Aries, Taurus, Gemini, Cancer, Leo, Virgo, Libra, Scorpius, Sagittarius, Capricornus, Aquarius, and Pisces.

Stars are designated chiefly in three ways: (1) by the technical name—the Greek letter followed by the genitive of the constellation, as $\alpha$ Leonis and $\beta$ Cygni, the method instituted by Johann Bayer in his *Uranometria* (1603), the first star atlas of much value, or by the number given by John Flamsteed, first Astronomer Royal of England, as 2 Canum Venaticorum; (2) by the catalog number, as Lalande 21185 and BD $+43°4305$; or (3) by the proper name, as Antares and Vega. A number of stars have all three designations. Only about 25 proper names are commonly in use; these include mostly the brightest stars. Other proper names are used by amateurs, whereas professional astronomers usually employ the Greek letter even for the brightest stars.

Various star atlases of practical value to students and especially observers have appeared since Bayer's. Norton's *Star Atlas* is one example of a modern small-scale chart, showing all naked-eye stars and many important objects, such as star clusters, nebulae, double and variable stars, co-ordinate systems, and circles. Charts on a larger scale become professional in type. The Beyer-Graff is a series on a larger scale (1 cm. $= 1°$), covering (in 27 charts) the northern sky and somewhat more; it records stars to magnitude 9.2. The Córdoba is another modern series of charts, and this covers the southern hemisphere. A famous chart is Friedrich Wilhelm August Argelander's *Durchmusterung* (Bonn, 1859-1862) of forty large sheets and reaching the 9th and 10th magnitudes; it covers the sky from the north pole to declination $-2°$, and the scale is 2 cm. $= 1°$; over 320,000 stars are shown. Although the stars were drawn from observations made with a small telescope, it is of great value.

Later, Eduard Schönfeld extended the series to declination −23°. The Franklin-Adams charts are a series of 206 photographic plates covering the whole sky, the scale being 1.5 cm. = 1°, and the magnitude reached being at least 14. The Wolf-Palissa is a series of photo charts along the ecliptic, the faintest magnitude being about 17. The unfinished *Carte du ciel* series of astrographic charts were planned in 1887 as an extensive international co-operative project involving eighteen observatories. The charts are made with large photographic refractors and are designed to show three million to four million stars when completed.

Star catalogs are a valuable asset to the astronomer. Commonly, the magnitude, right ascension, declination, precession, spectral type, and so on, are tabulated. Hipparchus is supposed to have made the earliest one, but no copies are extant. The *Almagest* of Ptolemy is the earliest one that has survived. The *Durchmusterung* of Argelander is the basis from which the charts for the atlas of the same name were drawn. Here, the stars are listed in zones for each degree of declination. The *Cape Photographic Durchmusterung* (1899) was the result of the efforts of David Gill, of the Cape Observatory at Capetown, who photographed nearly 500,000 stars, and Jacobus Cornelis Kapteyn of Groningen, who measured the plates. The work covers stars from −18° dec. to the south celestial pole. The *Henry Draper Catalogue,* compiled by Annie J. Cannon of the Harvard College Observatory, gives the visual and photographic magnitudes and spectral classes of 225,000 stars. Many other star catalogs exist, such as Sherburne Wesley Burnham's *General Catalogue of Double Stars,* Robert Grant Aitken's *General Catalogue of Double Stars* (1932), listing over 17,000 double stars with technical data on each, the Yale catalog of parallaxes by Frank Schlesinger, a standard reference for stellar parallax, and the work of Lewis Boss, *General Catalogue of 33,342 Stars* (1937), published by the Carnegie Institution. The unfinished *Astrographic Catalogue,* from which the *Carte du Ciel* is made, is very comprehensive, and will list several million stars.

## DISTANCES OF STARS

The stars are so far away that their known distances are almost unbelievable and in any case very difficult to comprehend. A model of the solar system on the scale of 1 ft.= 1 A.U. (astronomical unit or distance earth-to-sun) is a good working scheme to show all objects of the system conveniently. On this scale, Pluto would be 40 ft. from the sun. Inasmuch as the nearest star (α Centauri) is 270,000 A.U. distant, it would have to be 50 mi. from the sun in this model. This is only a beginning: to show the distance of the most remote stars belonging to our stellar system (the Milky Way), these stars would have to be of the order of 1,000,000 mi. from the sun, in the same model, inasmuch as some stars of the Milky Way are 20,000 times the distance of the nearest. Here, the model becomes unmanageable; nor have we yet represented the outer regions of space. Far beyond—many times as far—are the extragalactic nebulae, each with its unnumbered stars.

Distances of the nearer stars are measured by trigonometric methods of the surveyor, using a base line and measuring angles to the star. The base line of the diameter of the earth's orbit (186,000,000 mi.) is employed, although it is still too short for all but a few thousand stars. The exact position of a star is obtained by a series of measurements with the earth in one position, and the observation is repeated six months later with the earth on the opposite side of its orbit. The process is difficult and requires very high precision. Many negatives are required for one satisfactory parallax, besides the necessary calculation.

The heliocentric parallax is the maximum angle subtended at a star by the radius of the earth's orbit, the earth being at its mean distance from the sun. The farther away the star is, the smaller its parallax. The first measurements (about 1838) by Friedrich Wilhelm Bessel, at Königsberg, yielded the parallax of the star 61 Cygni. Later, parallaxes of Vega and α Centauri were obtained. Since then, the parallaxes of some 5,000 stars have been measured. The nineteenth-century work was extremely arduous because the heliometer or the filar micrometer was employed; but twentieth-century methods have used photographic technique, and certain observatories (as Allegheny, Leander McCormick, and Greenwich) specialize in parallax. The change of position relative to fainter, more distant, stars is all that can be observed. The faint background comparison stars are relatively so far away that their parallaxes do not record. Corrections are often needed, for sometimes the comparison stars show a slight parallax, or they may have a motion in space of their own; also, during the period of measurement, the entire solar system moves in space carrying the observer

TABLE I. THE NEAREST STARS

| *Star* | *Distance* | | *Apparent visual magnitude* | *Diameter (Sun=1)* | *Luminosity (Sun=1)* |
|---|---|---|---|---|---|
| | *Parallax* | *Light-years* | | | |
| | ″ | | m | | |
| Proxima Centauri (α Cen C) | 0.762 | 4.3 | 11.3 | 0.03 | 0.00004 |
| α Centauri A | 0.756 | 4.3 | 0.3 | 0.95 | 1.0 |
| α Centauri B | 0.756 | 4.3 | 1.7 | 0.82 | 0.3 |
| Barnard's Star (Oph) | 0.543 | 6.0 | 9.5 | 0.22 | 0.0004 |
| Wolf 359 (Leo) | 0.403 | 8.1 | 13.5 | 0.07 | 0.00002 |
| Lalande 21185 (UMa) | 0.388 | 8.4 | 7.5 | 0.46 | 0.005 |
| α Canis Majoris A (Sirius) | 0.376 | 8.7 | −1.5 | 1.69 | 21. |
| α Canis Majoris B (Sirius) | 0.376 | 8.7 | 8.5 | 0.02 | 0.0021 |
| Ross 154 (Sgr) | 0.350 | 9.3 | 10.5 | 0.21 | 0.0004 |
| Luyten 789-6 (Aqr) | 0.328 | 9.9 | 12.3 | 0.12 | 0.00008 |
| Ross 248 | 0.314 | 10.4 | 12.2 | 0.13 | 0.0001 |
| ε Eridani | 0.303 | 10.8 | 3.7 | 0.88 | 0.25 |
| τ Ceti | 0.298 | 10.9 | 3.7 | 0.60 | 0.30 |
| 61 Cygni A | 0.296 | 11.0 | 5.4 | 0.48 | 0.063 |
| 61 Cygni B | 0.296 | 11.0 | 6.0 | 0.43 | 0.003 |
| α Canis Minoris A (Procyon) | 0.291 | 11.2 | 0.5 | 1.66 | 5.8 |
| α Canis Minoris B (Procyon) | 0.291 | 11.2 | 10.8 | 0.09 | 0.0004 |

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SOUTHERN MILKY WAY

*The famous "Coalsack" dark nebula is visible as a dark area near the center of the photo; and just to the right of, and slightly above, the dark area is the equally famous Southern Cross, formed by four stars (circled).*

The star $\alpha$ Centauri has a parallax of $0''.756$, and is the nearest "naked-eye" star to us. A faint companion to it, Proxima Centauri, has a parallax of $0''.762$; this is the largest known parallax, so that Proxima is our nearest star. The limit of reliable trigonometric parallaxes is around $0''.01$, which means that stars more remote than about 300 light-years cannot be measured by this method, and the distance must be found by other means.

**Units of Stellar Distance.** An astronomical unit is too small a unit for interstellar distances, so astronomers use the light-year and the parsec. A light-year is the distance light goes in a year, the value in miles being approximately 31,560,000 × 186,000 or 5.88 trillion miles. $\alpha$ Centauri, at a distance of 4.3 light-years is some 25,000,000,000,000 mi. away. The distance of a light-year represents about 63,300 A.U. Sometimes the parsec is used for very great distances. A star that had a parallax of $1''$ would be distant $206{,}265'' \div 63{,}300'' = 3.26$, or 3.26 light-years (the number 206,265 being the value of a radian, in seconds). No star known has such a large parallax. If $p$ represents a star's parallax, the distance in light-years is $3.26/p$; or in parsecs, $1/p$; or in astronomical units, $206{,}265/p$; or in miles, 5,880,000,000,000 × number of light-years.

## STELLAR LUMINOSITY

The sun's absolute visual magnitude is $+4.7$, and at the distance of 32.6 light-years it would look like a magnitude 5 star. Any star dimmer than the sun would be invisible to the unaided eye at the relatively small distance of 50 light-years. The sun, therefore, is but an average star; indeed a large majority of the stars we see are brighter than the sun. Consider an outer galaxy like the Great Nebula in Andromeda. We see, there, countless numbers of stars; but whatever stars of only the sun's luminosity are there, are invisible, being too dim to be seen from the solar system.

Some stars have but a small fraction of the sun's luminosity. The famous Barnard's Runaway Star is probably less than 0.0005 the sun's luminosity, and Proxima Centauri is only about 0.00007 as luminous as the sun. One of the very faintest known stars is van Biesbroeck's star of magnitude 18. It is 19 light-years distant, and of absolute magnitude 19.2; its luminosity is computed as around 1/550,000. Being 1/550,000 as bright as the sun, if placed at the sun's distance, it would not be much brighter than the full moon. But there are stars immensely brighter than the sun. Canopus, Rigel, and Deneb are each about 10,000 times as luminous as the sun. The notorious *S* Doradus, a star of magnitude 9 in the Greater Magellanic Cloud, has a luminosity 600,000 times the sun's. It has the greatest luminosity of any known star, although some of the supernovae may exceed it temporarily.

TABLE II. THE BRIGHTEST STARS

| *Star* | *Apparent visual magnitude* | *Approximate distance (light-years)* | *Luminosity (Sun=1)* |
|---|---|---|---|
| $\alpha$ Canis Majoris (Sirius) | $-1.^m58$ | 8.6 | 21 |
| $\alpha$ Carinae (Canopus) | −0.86 | 90 | 10,000 |
| $\alpha$ Centauri | +0.06 | 4.3 | 1.5 |
| $\alpha$ Lyrae (Vega) | 0.14 | 27 | 52 |
| $\alpha$ Aurigae (Capella) | 0.21 | 42 | 142 |
| $\alpha$ Boötis (Arcturus) | 0.24 | 32 | 94 |
| $\beta$ Orionis (Rigel) | 0.34 | 545 | 18,000 |
| $\alpha$ Canis Minoris (Procyon) | 0.48 | 11 | 6 |
| $\alpha$ Eridani (Achernar) | 0.60 | 70 | 248 |
| $\beta$ Centauri | 0.86 | 190 | 1,400 |
| $\alpha$ Aquilae (Altair) | 0.89 | 18 | 9 |
| $\alpha$ Orionis (Betelgeuse) | 0.92 | 300 | 2,600 |
| $\alpha$ Crucis | 1.05 | 150 | 1,700 |
| $\alpha$ Tauri (Aldebaran) | 1.06 | 55 | 126 |
| $\alpha$ Virginis (Spica) | 1.21 | 190 | 1,000 |
| $\beta$ Geminorum (Pollux) | 1.21 | 30 | 30 |
| $\alpha$ Scorpii (Antares) | 1.22 | 170 | 1,400 |
| $\alpha$ Piscis Austrini (Fomalhaut) | 1.29 | 27 | 13 |
| $\alpha$ Cygni (Deneb) | 1.33 | 465 | 10,000 |
| $\alpha$ Leonis (Regulus) | 1.34 | 70 | 143 |
| $\beta$ Crucis | 1.50 | 400 | 2,200 |
| $\alpha$ Geminorum (Castor) | 1.58 | 45 | 41 |

Giant and supergiant are terms referring to brilliance and not to size. Giants, like Arcturus, are far more luminous than ordinary stars, while supergiants, such as Antares, are exceedingly luminous. As the value of luminosity decreases, the relative number of stars of low luminosity increases rapidly; that is, for every supergiant there are many thousands of stars of the sun's intrinsic brightness, and hundreds of thousands of those of very low brightness. Although in a given region of the sky the low-luminosity stars are more numerous, yet the high-luminosity ones are more numerous as discerned with the unaided eye.

## STELLAR DIMENSIONS

Star diameters are important in stellar investigation. No star in the heavens is near enough to show any disk even in the largest telescopes, the stars exhibiting themselves only as points of light. It is possible to measure the angular diameters of a few stars with the stellar interferometer. The diameter in arc, together with the distance, gives the linear diameter in miles, although the accuracy depends upon the accuracy in the measurement of parallax for distance. At Mt. Wilson, Francis Gladheim Pease first measured the diameter of Betelgeuse with the 20-ft. interferometer. The diameter proved to be considerably larger than the earth's orbit. Only the largest stars can be measured, and they have been found to be 10 to over 400 times the sun's diameter.

The bright reddish and orange stars are the largest and are selected for measurement. All of those measured are vastly larger than the sun.

Diameters are also obtained indirectly by calculation from the observed color index and the absolute magnitude. Eclipsing binary stars sometimes have their size estimated, for the form of the light-curve of the star allows the diameters to be found in comparison to the mean distance of separation of the pair.

**Mass and Density.** The mass of a star, or quantity of matter contained, can be found directly only in the case of binary systems where the parallax and the orbit of the revolving pair are already observed. The combined masses of the two components are determined; but only in certain cases can the mass of a single component of the binary be found. The masses do not vary nearly as much as the size and temperature. Masses are seldom found over three times the sun's mass. For density of stars, the mean density is calculated, for the centers are surely far denser than regions near the surface. A wide range is exhibited. The red giant and supergiant stars are only about as dense as a laboratory vacuum, or considerably less than 0.001 the density of air. The low stellar densities grade into medium, then into high, and finally into incredibly great densities in the white-dwarf stars, like the companion of Sirius. The density of this star is calculated at 27,000 times that of the sun or about 40,000 times the density of water. While it has the mass of a star it is only the size of a planet, and 1 cu. in. of its average material if placed on the earth would weigh a ton. Even so, the star is held to be in the gaseous state and its atoms are thought to be completely ionized—that is, entirely stripped of their revolving electrons—and very closely packed. The surface temperatures of stars range from about 1,600° K, for the coolest or red stars to around 50,000° K for the hottest or blue stars. Thus, the temperatures change as one goes from one spectral class to another, and the color of the star appears to depend upon its temperature.

**Mass-luminosity Relation.** A simple law has been discovered for the relation between the mass and the luminosity of a star: the greater the mass, the more luminous the star is, and in fact a mass-luminosity curve can be drawn on which most of the stars fall. Stars of small mass (like Krüger 60 B), having little light-giving power, fall near the bottom of the curve, while Capella and other massive stars are near the top. The explanation appears to be that the massive stars develop a temperature higher than other stars, and the heat finds its way to the surface and is radiated away more rapidly than with a less massive star. The mass-luminosity curve is drawn to represent known stars, and is believed to hold for those whose masses or temperatures have not been measured. Many stellar distances are known, as well as the apparent magnitudes, hence their absolute magnitudes become known by formula; therefore, the masses can be estimated from the curve.

**Stellar Interiors.** Ordinary or nonvariable stars are believed to be in a balanced state of equilibrium, in which opposing forces are at work. One is the gravitative force attempting to pull all parts of the body toward the center. This is balanced by the gas pressure, caused by motion of the molecules of the star's substance, which tends to expand the star. Radiation pressure, or actual pressure of light, adds its effect to gas pressure. The hotter the star is, the greater the effect of gas and radiation pressures. According to theoretical physicists, the pressure from superincumbent gases, and the temperature also, increase greatly toward the center of a star. Recent estimates put the central temperature of the sun at 25,000,000° C. Red giant stars probably have a lesser temperature, but still a few million degrees, while at the other extreme Eddington believed the temperature at the center of a white-dwarf star may reach 1,000,000,000° C.

Table III. Largest Stars*

| *Star* | *Diameter* | | *Luminosity* (*Sun*=1) |
|---|---|---|---|
| | (*Sun*=1) | *Millions of miles* | |
| α Herculis | 800 | 690 | 1,900 |
| ο Ceti (Mira) | 460 | 400 | 180 |
| α Orionis (Betelgeuse) | 460 | 400 | 2,600 |
| α Scorpii (Antares) | 330 | 285 | 1,400 |
| β Pegasi | 115 | 100 | 500 |
| α Tauri (Aldebaran) | 40 | 35 | 126 |
| α Boötis (Arcturus) | 22 | 19 | 94 |
| α Aurigae (Capella) | 16 | 14 | 142 |

*Diameters difficult to measure and vary in different measurements; table only general guide. Besides the above, ζ Aurigae has been estimated as 200 to 300 times the sun's diameter and ε Aurigae as of the order of 3,000 times. The smallest white-dwarf star, L 886-6 Monocerotis, has a diameter of perhaps only 2,500 mi.

## STELLAR MOTIONS

The expression "fixed stars" is used because the various constellations appear to maintain the same configurations throughout time. Yet this is an illusion due to their immense distances. All the stars are in motion. Moreover they are at different distances from the earth; that is, any group making up part of a constellation really exists in three dimensions; if one were in the midst of a constellation one would then see its stars in various directions all around.

The daily rotation of the earth causes the stars to be forever rising in the east and setting in the west. The yearly revolution of the earth around the sun causes the stars to cross the meridian a bit earlier each day as the season advances. Exact observations of right ascension and declination of a star made at different times are found to vary. The change is accounted for partly by precession of the equinoxes (together with nutation) and aberration of starlight. Again, the annual parallactic motion, due to the earth's revolution, is also observable with the nearer stars. These motions are not real motions of the stars; that is, the stars have their own individual movements in space.

**Proper Motion.** The actual motion of a star, considered as angular measure on the celestial sphere from one point to

LESSER MAGELLANIC CLOUD

*A typical irregular extra-galactic nebula, or galaxy, in Tucana, near the south celestial pole. It shows no spiral but is resolvable into stars, star clusters, and nebulous clouds.*

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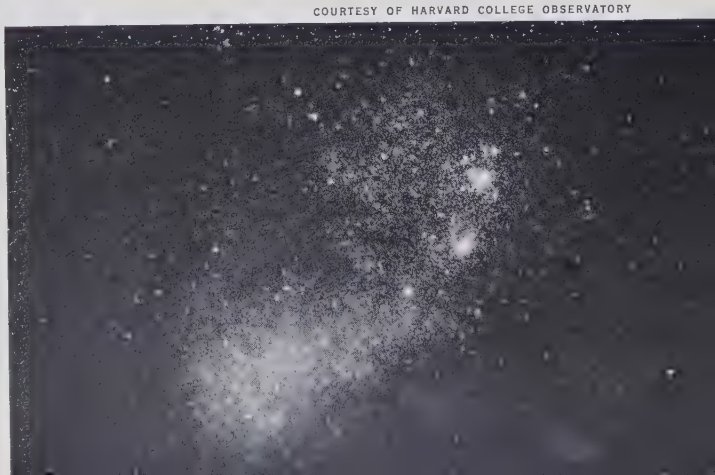


another, is its proper motion; it represents a displacement of the position between intervals of observation. Proper motion is always small, commonly only a few seconds of arc per hundred years. It is detected by comparing photographs (made at long intervals of time) under the blink microscope; or it may be determined by comparison of positions in star catalogs, and again the interval of comparison should be as long as possible for accuracy. The star having the largest proper motion is Barnard's Runaway star—discovered by Edward Emerson Barnard at Yerkes—the proper motion being 10″.25 per year. This motion is exceptional: the constellations would change in appearance during a person's lifetime, if all the stars moved as fast as Barnard's star. The magnitude of this star is 9.7; it is, therefore, invisible to the unaided eye; and the only bright stars with large proper motion are $\alpha$ Centauri and $\alpha$ Boötis (Arcturus). The bright stars, on the average, do not have proper motions over 0″.1 per year. Proper motion is not a full description of stellar motion; large proper motion means either fast actual motion, or that the star is relatively near the earth and shows its motion more quickly. Taking a large number of stars, one finds proper motion increases as the distance from the earth diminishes.

**Components of Stellar Motion.** Proper motion, alone, does not fully describe a star's movement, as it is but the change in apparent place. The actual motion in three-dimensional space is the space motion, resolvable into two components: radial velocity and cross motion (or tangential velocity). These components represent km./sec. or mi./sec., and the radial velocity is the measure of the motion toward or away from the observer, while the cross motion is simply a measure of the proper motion which is an angle measured in arc. This is the star's speed with respect to the solar system at right angles to the line of sight from the earth. Most stars move in all directions and so show both radial and cross motions, indicating that their motion is at an angle to the line of sight from the earth. Radial velocities are observed by means of the shift of spectral lines in the spectrograms, in accordance with the Doppler-Fizeau principle: a star going away from the earth has its spectral lines displaced toward the red end, and a star coming toward the earth has its lines displaced toward the violet end. The radial velocity is given a + sign when the star is moving away from the observer and a — sign when the velocity is toward the observer. Many stars are found to have radial velocities of 20 mi./sec., and some exhibit five times the speed. A correction (reduction to the sun) is applied to computed radial velocities, because of the earth's velocity in its orbit. The corrections establish radial motions with respect to the center of the solar system.

The actual motions of the stars in space, therefore, are found by means of proper motions (deduced by observations over long intervals), radial velocities (measured on spectrograms), and the distances (determined by the heliocentric parallaxes made by observations at opposite points in the earth's orbit). Commonly, the space velocities of stars are less than 30 mi./sec., being similar to planetary speeds. A few dozen move at 60 mi./sec., or more. Arcturus' space velocity of over 80 mi./sec. appears to be the highest of any of the bright stars.

**Moving Stellar Groups.** While the majority of individual stars have random movements, the moving star clusters have their members in motion in space with equal velocity and in parallel courses. The common space motion of the component stars is what identifies them. When one plots the space motions of a moving cluster, one is reminded of a meteor radiant. If the star cluster is moving toward the earth, the star paths lead away from a diverging point, while if the cluster is receding, the paths lead toward a converging point. The Taurus moving cluster contains over 100 stars and includes many of the Hyades stars, though Aldebaran is not a member. The proper motions of the Taurus cluster stars converge to a point near Betelgeuse. The convergence is a perspective effect, the actual space motions of the cluster members being parallel and equal. Their distance from the earth is about 130 light-years. The Ursa Major cluster is another moving stellar group whose 40 or more stars share a common motion and make an immense sphere 500 light-years in diameter. Except for $\alpha$ and $\eta$, the stars in the Big Dipper belong to this, together with several other bright stars scattered over the sky, namely, $\alpha$ Coronae, $\alpha$ Canis Majoris (Sirius), $\delta$ Leonis, $\beta$ Aurigae, $\beta$ Eridani, and others. It is curious that the sun happens to be inside this moving cluster temporarily, although it does not belong to the group. (In these open star clusters the stars are so far apart that other stars not of the group are often discovered moving through the group.) The Orion moving cluster is another, including various bright Orion stars (except Betelgeuse); and the Scorpius-Centaurus cluster is still another, at a much greater distance. The latter group includes a fine array of luminous southern stars, such as the Southern Cross, Antares, and so forth.

COURTESY OF MT. WILSON OBSERVATORY

*H. V24 SPIRAL GALAXY IN COMA BERENICES, SEEN EDGEWISE*

**Rotation of the Galactic System.** The rotation of the galactic system is a type of stellar motion, as well as a motion of the sun and the earth. It is more difficult to prove that the Milky Way rotates than to prove planetary revolution, but it is being proved by modern methods. The conclusions arrived at have been reached by various means. In order to determine motion of the stars around the galactic center, one must observe stars which are very distant from the earth, those nearer the center of the system than the earth is, and those farther away. To observe the earth's local star cloud is of little use, because it, too, is in motion.

The center of the galaxy has been located by Harlow Shapley as being in the dense star clouds of Sagittarius. There is probably no great central star but there is a stellar concentration; this has the effect of causing the stars near the center to revolve faster than the outer stars.

The solar system appears to be located at a distance about two-thirds the way out from the center of the Milky Way at a distance of some 30,000 light-years. The entire galaxy of stars appears to be in rotation, in a clockwise direction as seen from the north galactic pole, that is, opposite to the direction of planetary revolution. The speed of revolution of the sun, the whole solar system, and the near-by stars, is about 200 mi./sec. (or somewhat less) around the galactic center, the present direction of motion being toward the constellation Cygnus. The period of galactic rotation (at the earth's distance) is some 200,000,000 years.

**Rotation of Stars.** In the case of the earth's own star (the sun), it is not difficult to observe the rotation time (25 days at the equator) by observing the progress of sunspots across the visible disk and by the Doppler shift in the spectroscope. But with the distant stars, no disk is observable and the problem is more difficult, though not insolvable. In a rotating star, the spectral lines of the light from the stellar limb turning away from the earth are shifted to the red end of the spectrum, and lines from the limb turning toward the earth, to the violet end. The total effect is thus a widening of the spectral lines of a star in rotation (unless the axis is directed toward the earth). Bluish *B* and *A* stars have equatorial rotation speeds up to nearly 200 mi./sec., or exceedingly fast compared to the sun; and Altair's rotation period is about ¼ of the earth's day. Some eclipsing binaries make known their rotation periods under special conditions, as one limb at a time is shown to the earth, the rest being in eclipse. Binary stars as a rule have high velocities of rotation.

## STAR CLUSTERS

These are groups of a dozen, a hundred, or thousands of stars that occur together in the sky. Star clusters are not an optical effect of all the stars being in the same line of sight, but are actually grouped together in space. They form one of the special objects of interest to telescope observers. Choice clusters, along with nebulae, colored double stars, and other celestial wonders, are given in observing lists in practical books on astronomy. The famous list of nebulae and clusters by Charles Messier includes a number (but by no means all) of the finest clusters. Johan Ludwig Emil Dreyer's *New General Catalogue* is an official source for thousands of star clusters, galactic nebulae, and outer galaxies. More recent lists are offered in observatory publications. The Pleiades, Hyades, and the Coma Berenices group are clusters resolved, in part, by the unaided eye. In the Pleiades, six stars are discernible by the eye alone, while several hundred of the group are revealed, along with the surrounding nebulosities, by long-exposure photographs with a large telescope or astrograph. Praesepe (the beehive cluster) and the double cluster *χ-h* Persei are examples of naked-eye clusters not resolved without optical aid.

**Open Clusters.** Open clusters belong to the earth's galactic system and are known, also, as galactic clusters. With low optical power, some exhibit only a few stars, but with larger telescopes most of them are shown to contain a few hundred and, some, a few thousand stars. Something over 300 are known to date, and there are likely many more not yet recognized. They often cover a space over 1° in diameter on the sky, and all are located near the plane of the Milky Way except for a few of the near-by ones, such as the Coma

COURTESY OF MT. WILSON OBSERVATORY

*MESSIER 13, GREAT STAR CLUSTER IN HERCULES*

*The finest globular cluster of the northern heavens. About 50,000 stars can be counted on a photographic negative; there are probably hundreds of thousands of other less bright stars in the cluster.*

cluster; that is, they seem to be arranged like the galactic stars, in a lens-shaped form. Variable stars are found practically lacking in this type of cluster, although some very luminous stars are found therein.

The Pleiades and the Hyades are the brightest open clusters; *χ-h* Persei and Praesepe also belong to this class. Distances of star clusters can be obtained only by indirect methods. The Hyades cluster is about 130 light-years away; the Coma group 260 light-years; and the Pleiades and Praesepe of the order of 500 light-years distant, whereas fainter open clusters extend to 15,000 light-years.

In the case of a number of the nearer clusters, the stars are quite widely scattered over the sky and are all moving as a unit. These are the moving clusters already described. Only by their similar motions can they be recognized as belonging to one cluster. An open cluster may be found moving through a group of other stars; or "interloper" stars may be moving through a cluster though not belonging to it.

**Globular Clusters.** Globular clusters are compact, spheroidal masses of many thousands of stars. Many offer a magnificent sight in a large telescope. The stars appear to be packed closely together but this is an illusion due to distance, although they do have a notable central condensation. Many are somewhat flattened, which implies rotation. Globular clusters lie outside the Milky Way plane and are most numerous in the great star clouds of Sagittarius, and in Ophiuchus. Any possible ones in the galactic plane are probably obscured by dust clouds and nebulous matter there. The globular clusters are arranged in a concentric manner with the galaxy, but they are not distributed evenly around the solar system, for the sun is not in the Milky Way's center. In this type of cluster, variable stars are found, to the extent of several hundred; they are the short-period cluster variables, of periods of about half an earth's day. Giant stars, supergiants, and the hot stars of the main-sequence abound in these clusters. Radial velocities determined for several globulars prove that the clusters are in rapid motion in space.

Only about 100 globular star clusters have been found in the galaxy. They are, therefore, relatively scarce, and this many are visible because of their bright stars. The brightest globular cluster is ω Centauri (NGC 5139), which appears like a hazy star of magnitude 4, though it is composed of innumerable stars of magnitude 12. The cluster 47 Tucanae is the next brightest. Both are southern objects and of singular beauty in the telescope. They are the nearest globulars, being about 20,000 light-years away. Messier 13 (NGC 6205) is the best one for northern observers. This and M 22 (NGC 6656 Sagittarii) are faintly seen with the unaided eye. The distance of M 13 is 34,000 light-years. Each contains some 60,000, and likely many more, stars of magnitude 13, and fainter. Other particularly good ones are M 55 Sagittarii, M 5 Serpentis, and M 3 Canum. Almost any globular has perhaps 50,000 stars which are observable, while near the center the stars are too concentrated to be discerned separately.

In the central densest parts of a cluster, the stars still have much room, though here the distances from one another become rather planetary than stellar. The central, condensed regions of globular clusters are about 15,000 light-years in diameter. The globulars are so far away that the earth's sun would be wholly invisible at their distances. The most remote globular found is NGC 2419, approximately 250,000 light-years distant. *See also* BINARY STARS; CONSTELLATIONS; GALAXIES; MILKY WAY; MULTIPLE STARS; NOVA; SOLAR SYSTEM; SPECTRA, STELLAR AND SOLAR; STELLAR MAGNITUDE; VARIABLE STARS. H. S. R.

**STAR-SPANGLED BANNER, THE.** The origin of the tune of the national anthem of the United States is unknown. It first appeared in 1775 as the song of the Anacreontic Society in London, an organization of wealthy music-lovers who met periodically to enjoy an orchestral concert, followed by a "cold collation" and some informal singing. Ralph Tomlinson, a lawyer from Lincoln's Inn and a president of the Society, wrote the words—*To Anacreon in Heaven.* These were first published in *The Vocal Magazine* in August 1778, and a sheet-music edition, with both words and music, was issued by Longman & Broderip in 1779. No composer is mentioned in any extant eighteenth century edition. Attempts have been made to assign the credit to Samuel Arnold, who conducted the Society's orchestra, and to John Stafford Smith, who published an arrangement for three voices in 1799, but it is much more probable that the tune had a prior existence—possibly a military one, since it has many characteristics of a trumpet march of the period—before the Anacreontic Society adapted it for their purposes and made it famous.

The earliest documentary proof of the presence of the song in the United States is the publication in New York newspapers in 1793 of a patriotic parody—*The genius of France from his star begem'd throne*—written to be sung to the tune. By 1795, the words of *To Anacreon in Heaven,* as well as other parodies, had begun to appear in American collections of songs, and to judge from the steady increase in such publications the melody gained rapidly in popularity, particularly at the elaborate town banquets held in each community to celebrate Washington's Birthday and the Fourth of July. At least a hundred patriotic parodies have survived. Francis Scott Key wrote his first poem to the tune in December 1805, and sang it himself at a dinner in Georgetown in honor of Stephen Decatur.

Key's more famous poem to the same tune was written later under the provocation of more stirring circumstances. Late in August 1814, the British had made a brief but successful sortie from their fleet in Chesapeake Bay, and had taken the city of Washington and burned a number of public buildings. On their way back to their ships, the British arrested a Dr. Beanes of Upper Marlborough for some offence which they counted treachery. Key had considerable political influence in Washington, and Dr. Beanes's friends persuaded him to undertake a trip to the British fleet to gain Beanes's release. Key left Washington for Baltimore on September 3, and together with Col. John S. Skinner, the United States cartel agent, set sail down the Bay on an unidentified sloop owned by one Benjamin Ferguson. The sloop caught up with the British fleet off the mouth of the Potomac on September 7. Dr. Beanes's release was finally agreed upon, but since the British had discussed their plans of attacking Baltimore in front of Key and Skinner the American party was detained for fear they might give warning to their countrymen. The whole fleet started north on the 8th, and was sighted off Baltimore on Sunday morning, September 11. During the following night, British troops were landed on North Point for a flank attack on the city, and the next day the smaller bombers and rocket ships were worked up the mouth of the Patapsco River for a frontal attack on Fort McHenry. Key, Skinner, Beanes, and their crew of eleven were returned to Ferguson's sloop under guard. During the day and evening of the 13th, the British bomb-ships stayed for the most part out of range of the small cannon of the Fort, and easily lobbed some 1800 bombs into and around the enclosure. When the firing ceased, around one o'clock in the morning of the 14th, tension increased on the sloop, since those on board had no way of telling whether the silence meant that the Fort had fallen, and it was only when they could finally see through the mist and drizzle of the morning that the over-sized flag on the Fort was still flying that they realized their fears were unfounded. Actually, the British had no desire to risk a serious engagement, since their orders from London directed them to attack New Orleans, not cities on the eastern seaboard, and when they discovered how well prepared Baltimore actually was they started re-embarking their troops from North Point during the night. When Key saw that the attack was over and the danger passed, he was stirred by a poetic impulse, and on the back of a letter he found in his pocket he started sketching his verses. The sloop was allowed to land in Baltimore that evening, and in his hotel Key wrote out a clean copy of his poem. It is probable that this manuscript is the one which is now preserved in the Walters Art Gallery in Baltimore. The next morning, Col. Skinner called upon Key and persuaded him to go to the offices of the Baltimore *American,* where the poem was set up in handbill form. In less than a week it had been reprinted in two Baltimore papers, and, not much more than a month later, a sheet-music edition was published by Joseph Carr with a musical setting arranged by Carr's son, Thomas. Other newspapers around the country picked up the stirring words from the Baltimore papers and, before the year was out, the song had also been included in *The Analectic Magazine* and three popular song books.

The melody was already common property, and it was not long before Key's words were generally recognized as the best embodiment of the American ideas of patriotism in song form which the country had produced. Apparently, during these earlier years, the populace was undeterred by the rather wide range of the melody, and it was constantly published in songsters side by side with the latest minstrel jig and theatrical hit. No other patriotic song appears so regularly and over such a long period, and therefore its final elevation to the position of national anthem seems to be

justified by this extended popular acclamation. Army and Navy regulations began to require its use in the 1890's, when circumstances called for the performance of a national anthem, and President Woodrow Wilson confirmed this usage during World War I in approving a new edition of the regulations. Congress, however, allowed a whole series of bills on the subject to die in committee, until finally the Seventy-First Congress passed Public Law 823 (U.S. Code 36, sec. 144), and President Hoover signed the bill on March 3, 1931, making the song the national anthem. The complete bill reads:

> *Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,* That the composition consisting of the words and music known as The Star-Spangled Banner is designated the national anthem of the United States of America.

Neither this nor subsequent legislation defines which words or which music should be used, and since countless corruptions of the words and innumerable variations in the melody and harmony exist, we still do not have an "official version" of the anthem. R. S. H.

**STAR THISTLE,** a large genus, *Centaurea,* having flower heads surrounded sometimes by a starlike arrangement of spiny bristles. These plants are annual or perennial herbs of the family Compositae, mostly native to the Old World. The purple-flowered *C. calcitrapa* and the yellow-flowered *C. solstitialis,* both of which have stout spines radiating from the dense flower heads, and several other species are naturalized as weeds in North America. The American star thistle, *C. americana,* of the southwestern United States and Mexico, has showy pinkish flowers and grows nearly 6 ft. high. J. C. Wis.

**STAS, JEAN SERVAIS** [sta's] (1813-1891), Belgian chemist, famous for his precise determinations of the atomic weights of elements, was born in Louvain, Aug. 21, 1813. In 1840 he became professor of chemistry at the Ecole Royale Militaire at Brussels, and in 1865 was appointed to an important post in the Belgian mint. He resigned in 1872 and lived in retirement until his death nineteen years later.

Stas forms the middle link between Dumas, with whom he worked, and Theodore William Richards—a chain of great scientists who carefully determined the atomic weights of many elements. Their work has shown the finest technique ever achieved in the field of quantitative analysis. When Stas commenced his work, which extended to the determination of the atomic weights of many important elements, he had accepted William Prout's hypothesis that the weights of all elements were multiples of that of hydrogen. As his investigations progressed, however, he found the hypothesis partly disproved, for example, by the fact that the atomic weight of chlorine was 35.5 and not a multiple of 1. Dumas and Stas also investigated the action of potash upon various alcohols and ethers and proved that all true alcohols may produce corresponding acids. In 1850, while working on a poison gas, Stas devised a method for detecting vegetable alkaloids that is still widely used by toxicologists. In 1885 Stas was awarded the Davy medal of the Royal Society for his researches. He is said to have exemplified the "maximum of human patience" in his scientific work. His first paper on the atomic weights of ten elements (1850) was followed by his *Recherches sur les rapports reciproques des poids atomiques* and *Nouvelles recherches sur les lois des proportions chemiques.* Stas died in Brussels on Dec. 13, 1891. H. N. A.

**STASSEN, HAROLD EDWARD** (1907- ), American politician and educator, was born at West St. Paul, Minn., on Apr. 13, 1907. He received his early education in the local country schools and in St. Paul, and was graduated from the University of Minnesota in 1927 where he received his law degree two years later. He began practicing law in South St. Paul, Minn., and from 1930 to 1938 was county attorney of Dakota County. In 1938, he was elected governor of Minnesota, the youngest ever elevated to that office in the United States, and was re-elected in 1940 and 1942. Stassen had campaigned for office on a platform promising a liberal brand of legislation and economy in state government. In 1943, Stassen resigned his post as governor to join the United States Navy, and was assigned to duty in the Pacific area where he served as fleet flag officer on the staff of Admiral William F. Halsey. In 1944, he was appointed assistant chief of staff. In 1945, he was recalled from the Pacific by President Roosevelt and appointed United States delegate to the San Francisco meeting that wrote the charter of the United Nations. Resuming his law practice in Minneapolis, he entered actively into national politics, and was a leading candidate for the Republican presidential nomination in 1948 and 1952. He was appointed president of the University of Pennsylvania in July 1948, serving until his resignation in 1953. In 1952 he worked as political strategist for Dwight D. Eisenhower's successful campaign for the Presidency, in recognition for which Stassen was named Mutual Security Director in the new administration. In this capacity he visited Europe and the Near East during 1953, and the following year made an inspection trip to the Far East. He also became director of the Foreign Operations Administration in August 1953.

**STATE.** *See* CHURCH AND STATE; GOVERNMENT; POLITICAL SCIENCE AND PHILOSOPHY.

**STATE, DEPARTMENT OF,** an administrative department of the United States Government, first established as the Department of Foreign Affairs in July 1789 but given its present title two months later. At this time Congress invested the department with certain domestic functions; but these are of relatively minor importance, almost all of the department's activities having to do with the policy of the United States toward foreign countries or toward international organizations, for example, the United Nations. Major decisions as to foreign policy may be made directly by the President; but all the detailed work of implementing foreign policy, of making day-to-day decisions on foreign relations, of carrying on diplomatic and consular intercourse and formal negotiations with foreign governments, and of fostering national interests abroad devolves upon the department. The advance of the United States as a world power has augmented the variety and scope of these basic responsibilities, and the department has added, or expanded, its duties to include communication and intelligence services, the dissemination of cultural and information programs, and sundry activities having to do with international commercial and fiscal policy.

Operations of the department are distributed among nineteen separate offices, the heads of which clear through one of eight assistant secretaries or one of three special assistants. These officials, in turn, are responsible to the Under Secretary of State and to the Secretary of State, the latter being immediately responsible to the President for all departmental affairs. In 1952 the United States maintained 59 embassies and 14 legations.

Departmental personnel at home and abroad constitute the Foreign Service of the United States. Certain of the career personnel, including secretaries and counselors of legations and embassies, attachés, and the various grades of consul, are designated Foreign Service Officers. Under legislation enacted in 1924 and 1946, these are given professional status as to grade, compensation, promotion and tenure.

Because the Department of State is the oldest and, therefore, the senior department of the government, the Secretary of State is the ranking member of the President's cabinet. Under the Presidential Succession Act of 1886, the Secretary of State was the first in line of succession to the Presidency if that office should become vacant at a time when there was no Vice-President. This line of succession was modified by the Presidential Succession Act of 1947, which placed the Secretary of State after the Speaker of the House of Representatives and the President pro tempore of the Senate in the order of succession. A. J. Z.

**STATE AID.** *See* Public Finance (*Governmental Revenues and Other Receipts*).

**STATE COLLEGE,** an educational borough in central Pennsylvania, in Centre Co., situated 40 mi. northeast of Altoona. Coal is a natural resource of the region, and many caves are found in the surrounding area. The borough was founded and incorporated in 1875. Before this, Pennsylvania State College was founded in 1855, and the community derived its name from the college. A council and a borough manager administer the community, whose economic life is largely dependent upon the activities of the college. However, there are poultry, dairy, and grain farms in the area. Transportation is afforded by the Bellefonte Central Railroad and the All American Airways. Pop. 1950, 17,227.

**STATE GOVERNMENT,** the basic political unit in the federal system of the United States. According to this system, the governmental powers are constitutionally divided on a territorial basis between a central government, on the one hand, and smaller component units, on the other. The states are welded into national unity by the Constitution of the United States. No formal change may be made in this fundamental law of the land without the approval of three fourths of the states, expressed either through their state legislatures, or through conventions held in three fourths of the states. The Congress of the United States selects the particular method of approval.

**Delegated Powers.** Under the division of powers in the federal system of the United States, certain specific powers are delegated to the national government, certain powers are expressly denied to the states, and all others "are reserved to the states respectively or to the people." In a strict legal sense, therefore, the national and state governments are coordinate; neither is subordinate to the other, and neither can destroy or alter the powers of the other.

**Centralization.** This constitutional formula, however, has not always proved successful in actual practice. The first, and perhaps most important, reason for this failure is the constitutional provision that, in case of conflict between the asserted powers of the national government and those of the states, the former shall prevail as the "supreme law of the land." The application of this principle in the environment of a rapidly expanding economy and changing social structure has profoundly altered the practical position of the states in the federal system of the country. This change is commonly designated as governmental centralization, which may be briefly defined as the shift of influence and power from a lower to a higher level of government. For many years such a shift has been taking place in the United States, the general effect of which has been to transfer power and responsibility from the states to the national government. The roots of the widespread centralization of the twentieth century are imbedded in the industrial changes of the early nineteenth century. The vast transformation in the social structure and in the economic life, which grew out of these changes, furnished the basis for the steady advancement of centralization since the Civil War. Many have decried this growing encroachment upon states' rights for one reason or another, but not one has been able to restrain it.

Although further centralization may be expected, there seems to be no immediate danger that the forty-eight commonwealth governments will not continue as important units of the Federal Government.

**State Powers.** From the points of view of its relation to the individual citizen and the community, its fundamental position in the federal system of the United States Government, and the contribution of the states as laboratories for political experimentation, it would be difficult to overemphasize the importance of state government. The states have the power to make and alter their own institutions of government, subject to the constitutional requirement that they be republican in form; the power to regulate the suffrage in Federal as well as state elections, subject to the Fifteenth and Nineteenth Amendments to the Constitution; the power to levy and collect taxes, except upon instruments of the Federal Government and interstate and foreign commerce; the power to make and enforce police regulations of all kinds, subject to the due process and equal protection clauses of the Fourteenth Amendment; the power to promote the welfare of its people by fostering and promoting education, public health, agriculture, conservation of natural resources, and by supplying many other services; the power to deal with the whole field of private law regulating the relationship of man to man, and involving the family, the system of private property, and other institutions of modern civilization.

**Uniform Pattern of State Government.** There is a striking uniformity in the structure of state government throughout the United States. Each of the states, except Nebraska, has a bicameral, or two-chambered, legislature, and each has an independent executive, the governor. All of them have a more or less complicated system of courts, the judges of which are, in most cases, elected by popular vote. The governor and a varying number of other executive officers are elected by popular vote. In nearly all of the states, constitutional amendments may not be adopted without the approval of the electorate; in a considerable number of states, amendments may be initiated directly by the voters, and may later be ratified by them, without the participation of the legislature or a convention. Thus, the powers of the electorate are more numerous, if not more effective, than in the national government.

**Constitutional History.** The development of state governments has been marked by an early distrust of the executive, a later strengthening of the executive and judicial branches at the expense of the legislative, and an increasing popular control over all branches of the government. The framers of most of the first state constitutions were chiefly concerned with making the legislature supreme. Their previous unhappy experience with irresponsible colonial governors appointed from England was too fresh in their memories to permit more than a formal declaration of the avowed prin-

ciple of the separation of powers. As the legislature declined in popular esteem and confidence and the governor gained in political influence and power, through popular election and in other ways, about the middle of the nineteenth century this situation was reversed and the governor became the real legislative leader of the state. Despite separation-of-powers clauses in state constitutions which provide that the legislative, executive, and judicial departments shall be separate and distinct, these same constitutions vest important legislative powers in the governor.

The governor is elected by popular vote in all the states, and he exercises both executive and legislative powers. In most of the states, the judicial power of pardon is also vested in the governor, either in him alone or jointly in the governor and a board of pardons. In the majority of states, his legislative powers are more significant than his executive or administrative powers. The executive power of enforcing laws is shared with a varying number of other elected officials who owe no responsibility to the governor. Moreover, in many states, such powers of appointment and removal as he has are severely restricted. Thus his chief constitutional duty to "see that the laws of the State are faithfully executed" is in many instances more theoretical than actual.

Since about 1910, however, the voters have regarded with increasing approval the leadership of the governor in legislative matters, a development which led to a reorganization movement, beginning concretely with a somewhat dramatic reorganization of the administrative system of Illinois in 1917. In consequence, the governor has, with varying degrees of success, become head of the administration in a majority of the states. State government has accordingly come to revolve largely around the leadership of the governor in both legislation and administration, and the effectiveness of this leadership goes a long way toward determining the success or failure of state government.

The basis of the governor's participation in legislation is both constitutional and extraconstitutional. Among the legislative powers vested directly in the governor are the qualified veto power, which in thirty-nine states includes the power to veto items in appropriation bills; the power to send messages to the legislature with recommendations for the adoption of his legislative program; the power to call special sessions of the legislature for the consideration of urgent problems which, in the judgment of the governor, should not await the next regular session.

Of equal, if not greater, importance are those extraconstitutional influences which derive from the governor's position, as party leader and as exponent of public opinion.

G. W. Sp.

**STATE LEGISLATURE,** the legislative body provided by each of the forty-eight states of the United States by its constitution. These bodies are bicameral except in Nebraska, which adopted a unicameral form in 1937. The structure of the legislatures and their powers and duties are prescribed, and the legislative process partially regulated, by the state constitutions. There is no complete listing of their powers, since states, unlike the Federal Government, are said to have residual or reserved powers, and, hence, legislatures are able to do anything not forbidden by the state and Federal constitutions. Major fields of authority include: highways, education, health, welfare, state institutions, taxing, conservation of resources, regulation of utilities and other businesses, and criminal law. In the final analysis, state legislative powers are interpreted by state and Federal courts in cases in which the constitutionality of statutes is questioned.

In colonial days assemblies were regarded as the stronghold of popular liberties against royal governors and the English Parliament, and when these were swept away by revolution the people naturally set up state governments in which the legislature was predominant. The constitutional history of the states shows a gradual shift in power from the legislature toward that of the state courts and the executive branch headed by the governor. This shift in power has come through constitutional change, statutes, custom and usage, and court decisions.

The state legislatures vary as to structure, term, pay, procedure, and committee setup. The lower chamber, usually called the house of representatives, ranges from 35 members in Delaware to 399 in New Hampshire; the upper house, usually called the senate, ranges from 17 in Delaware and Nevada to 67 in Minnesota. The Nebraska legislature has 43 members. Population is the major basis of representation with the county widely used as the election district. Urban areas are commonly discriminated against in favor of rural areas. Districts are sometimes gerrymandered for party reasons. Terms in the lower house run from one to four years, with a two-year term usual; in the upper house the range is from two to four years with a majority of states having the four-year term. Regular sessions are held every two years in most states (generally in the odd-numbered years), limitations on the length of sessions being common. Compensation is usually small but runs as high as $5,000 per year.

The legislative power of both houses is equal, except that money bills must be introduced in the lower house. In most states the senate shares the executive power of appointment because of the power of confirming or rejecting the governor's nominees for department headships and other positions. The senate also tries impeachment cases brought by the lower house. The legislatures adopt rules of organization and procedure, which have evolved into an intricate pattern workable only by experienced members. Committees are used in every state to sift bills, hold public hearings thereon, and report their findings. Massachusetts, Maine, and Connecticut employ the joint committee system, thus saving the duplicate committee work which exists in most states. Legislative reference and bill-drafting services exist in a majority of states, and, beginning in Kansas in 1933, legislative councils have found favor in a number of commonwealths as an aid to planning legislation. Complex demands of modern legislative programs indicate the need for further reforms, including more effective control of lobbies, better office space and more adequate clerical services for committees, reorganization of the committee system, selection of legislative employees on the basis of merit rather than spoils, transfer of damage claims and private pension requests to an administrative agency, and more frequent legislative sessions with adequate advance planning. *See also* Legislative Council; Legislative Reference Bureau.

E. F. D.

**STATEN ISLAND.** *See* New York; Richmond.

**STATESBORO** [ste′tsbʌ′ro], a city in east central Georgia, the county seat of Bulloch Co., located 50 mi. northwest of Savannah. Incorporated in 1866, Statesboro is administered by a mayor and council. Georgia Teachers College, a unit of the university system of Georgia, is located near by. Statesboro has transportation furnished by the Central of Georgia Railway. Situated in a farming district where peanuts are grown extensively, the city's main industry is concerned with peanut processing. The production of turpentine is also important. Pop. 1950, 6,097.

**STATES OF THE CHURCH** or **PAPAL STATES,** the name given to the territories in central Italy that were under the temporal rule of the Pope from 754 to 1870. The extent of the papal possessions varied in size from time to time; in 1859 just before the Austro-Italian War they embraced more than 16,000 sq. mi. and had a population of over 3,000,000. At that time they extended over the whole of central Italy and were bounded by the Lombardo-Venetian Kingdom on the northwest, by the Adriatic Sea on the northeast, by the Kingdom of Naples on the southeast, by the Mediterranean on the southwest, and on the west by the grand-duchy of Tuscany and the duchy of Modena. The Papal States also included Benevento and Pontecorvo. In present-day Italy these territories are now included in Latium, Umbria, Marche, and part of Emilia-Romagna.

At first, under the law of 321, which gave the Catholic Church power to hold and to transmit property, the papal possessions were the private property of the Church, which was in the same position as any other wealthy landowner. Full sovereignty is generally dated from 754 when the Frankish King Pepin, by the "Donation of Pepin," presented territory to the Pope and guaranteed the Pope in his possessions against the Lombards and the Byzantine Emperor. Under Charlemagne, Pope Adrian I was enabled to increase the territories to include almost the whole of central Italy. In turn, Charlemagne was crowned Holy Roman Emperor by Pope Leo III in 800.

For the next four centuries the difficulties of the Papal States came mostly from within. Various factions of the nobility in the city of Rome strove to acquire control of the papacy and its spiritual and temporal power. In the struggle the Pope was constantly forced to make sacrifices of territory and power to the Holy Roman Emperor in order to obtain protection against internal dangers. Papal power was restored under Pope Innocent III and in 1213, by a golden bull, the Emperor Frederick II confirmed the States of the Church as including the old Patrimony from Ceprano to Radicofani, the March of Ancona, the Duchy of Spoleto, the territories of Matilda, the County of Bertinoro south of Ravenna, the exarchate, and the Pentapolis. This settlement was jeopardized, however, by Frederick II and his successors. The defeat of the Hohenstaufen line confronted the States of the Church with even greater difficulties arising from the French. The next five hundred years saw a sharp decline in the power and extent of the States, culminating in the era of Napoleon. By the Congress of Vienna (1814-1815) the States were again re-established in their old boundaries except for Avignon and Venaissin and a narrow strip along the frontier of the Ferrara district north of the Po, which was given to Austria along with the right of garrisoning Ferrara and Comacchio. Many people living in the Italian peninsula, however, influenced by the ideas of the French Revolutionary and Napoleonic regimes, demanded national unification and a constitutional government. Their great enemy was Austria, and by its alliance with Austria, the Papacy continued to enrage the Italian liberals. The revolutions of 1848-1849 were generally unsuccessful, but thenceforth the Pope continued to remain in power only because he was protected by Austria and France. The establishment, in 1861, of the Kingdom of Italy over the protests of the Pope foreshadowed the end of the States of the Church. Effective power was now only in the hands of France; with the withdrawal of the French soldiers from Rome in 1870, troops from the Kingdom of Italy entered the city and the last remnants of the States of the Church were annexed to the Kingdom. The Pope excommunicated all parties who had a part in the occupation of the States of the Church and forbade Catholics to participate in Italian political life, but the possibility of the restoration of the States of the Church dimmed with the years. By the Law of Papal Guarantees of 1871 Italy sought to assure the Pope of his sovereignty of the Vatican, the Lateran, and Castel Gandolfo, but the Pope refused to accept or to recognize the act and shut himself up as the "Prisoner of the Vatican," appealing unavailingly for outside aid. Not until 1929, by the Lateran Treaty or Concordat, did the Pope recognize the accomplished fact of the destruction of the States of the Church. *See also* ITALY. S. J. H.

**STATES' RIGHTS,** a political doctrine in United States history, or the powers claimed under that doctrine. The Tenth Amendment to the Constitution declares: "The powers not delegated to the United States by the Constitution, nor prohibited by it to the States, are reserved to the States respectively, or to the people." Interpretation of this statement immediately divided political theorists into two schools: "Strict Constructionists," who construed the Amendment literally and narrowly; and "Loose Constructionists," who cited implied powers inhering in the Federal Government. The latter group, typified by Alexander Hamilton, formed the core of the emerging Federalist Party, dominated the first three administrations, and through John Marshall impregnated the formative decisions of the Supreme Court. The passage of the Alien and Sedition Acts in 1798 provoked an affirmation by the anti-Federalists (later called Democratic-Republicans, or Democrats) that the Constitution was a compact of states, each capable of judging and, if need be, rejecting Federal statutes. The statement of this position in the Kentucky and Virginia Resolutions of 1798-1799, drafted by Thomas Jefferson and James Madison, became the cornerstone of States' Rights.

The application of this doctrine was extremely varied, and its defenders and antagonists inconstant. Thus, Jefferson invoked the concept of implied powers to explain the purchase of Louisiana; the New England Federalists used the abandoned arguments of Jefferson at Hartford in 1814 to oppose the current war; and John C. Calhoun, an enthusiast for that war and for national as against sectional interests, became the spokesman for States' Rights when Andrew Jackson's tariff policy appeared to threaten the economy of South Carolina. Calhoun, Democrat, in 1828 challenged the authority of Jackson, another Democrat, by propounding the right of nullification, which led inexorably to the right of secession; while Webster, a Whig, supported Jackson on the inseparability of the Union in his famous debate with Hayne in 1830. Clearly those opposing and those defending States' Rights utilized the doctrine, not on its merits or demerits, but to support programs based on more cogent considerations.

States' Rights was long identified with the Democratic Party and the South, but in recent years Republicans have tended to champion state sovereignty on such issues as the use of tidelands oil. In the South, many defenders of the special institutions of the region have also returned to the States' Rights banner, to the point of forming a States' Rights Party. Its presidential candidate, J. Strom Thurmond, received 1,169,021 votes in 1948 and supported Republican candidates in 1952. *See also* DIXIECRATS. E. A.

**STATESVILLE,** a city in west central North Carolina, the county seat of Iredell Co., located north of the Catawba River, 41 mi. north of Charlotte, in an agricultural area where cotton, wheat, and corn are leading crops. Pine timber is

a natural resource of the region. Founded in 1750 by Scotch-Irish and Germans from Pennsylvania and Maryland and originally called Fourth Creek, Statesville was incorporated as a city about 1789. During the Civil War it was declared the temporary capital of the state by Governor Zeb Vance, following the fall of Raleigh. His home, the temporary state capitol, is a feature of historic interest. An unusual fact is that the entire city by official ordinance is a bird sanctuary. The Wallace Brothers Herbarium in Statesville contains a large collection of medicinal roots, herbs, and plants. The city is the seat of Mitchell College. Transportation is supplied by the Southern Railroad. Cotton yarn, cottonseed products, flour, feed, knitted fabrics, garments, bricks, and machinery for brickyards are leading manufactures. Pop. 1950, 16,901.

**STATE TAXES.** *See* TAXATION (*Types of Taxes*).

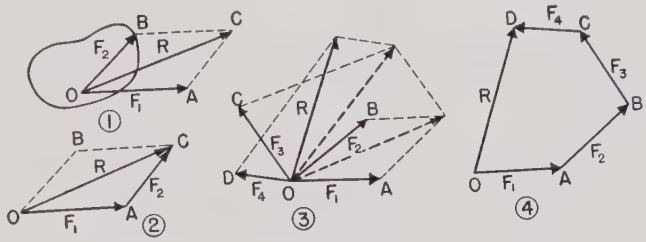
**STATICS** [stæ′tɪks], a branch of mechanics concerned with material bodies that remain at rest when subjected to the action of forces. Broadly speaking, it includes the theory of equilibrium of fluids and solids, but the accepted use of the term refers to a study of the equilibrium of rigid bodies and inextensible cords, belts, and chains. The theory of equilibrium of deformable solid bodies is in the province of the theories of elasticity and plasticity, and the equilibrium of liquids and gases is considered in fluid mechanics.

**Historical.** Statics is the oldest branch of mechanics, and some of its principles were doubtless understood by the Egyptians and Babylonians, as evidenced by the construction of pyramids and temples. Among the early contributors to the theory of statistics was Archimedes (c. 287-212 B.C.), who developed the theory of the lever and stated the basic law of hydrostatics. However, the structure of statics in its modern form stems from the work of Stevinus (1548-1620), who in 1586 stated the law of composition of forces, or parallelogram law, and employed it in the solution of a number of problems.

**Fundamental Principles.** The laws of statics follow from the general dynamical laws by considering the special case for which the velocities of the bodies vanish, but for historical and pedagogic reasons statics is frequently developed independently of dynamics on the basis of a certain set of postulates or principles. These are (*a*) the law of composition of forces, (*b*) the principle of equilibrium, and (*c*) the action and reaction principle. In dealing with rigid bodies, that is, ideal bodies which are not deformed when subjected to the action of forces, another principle, based on the concept of a rigid body, is introduced. This is the principle of transmissibility of force. This principle asserts that the state of a rigid body in equilibrium is not altered if the point of application of the force is shifted along the line of force action.

**Force as Vector.** It will suffice to consider force as an effort in the nature of a push or pull, having certain direction, magnitude, and a point of application. Mathematically, the force can be regarded as a vector, and hence it can be represented as a directed line segment whose length is a measure of the magnitude of the force. (To distinguish the vector quantities from other quantities which are characterized by the magnitude alone, vectors are printed in boldface type.)

**Parallelogram Law of Forces.** Consider a body (Fig. 1) subjected to the action of two forces $\boldsymbol{F}_1$ and $\boldsymbol{F}_2$ applied at some point $O$ of the body, which are represented in the figure by the directed line segments $\overrightarrow{OA}$ and $\overrightarrow{OB}$. It is suggested by experiments that the effect of the forces $\boldsymbol{F}_1$ and $\boldsymbol{F}_2$ is equivalent to the action of a single force $\boldsymbol{R}$ represented by the vector $\overrightarrow{OC}$. The magnitude of the vector $\boldsymbol{R}$ is equal to the length of the diagonal of the parallelogram constructed on vectors $\overrightarrow{OA}$ and $\overrightarrow{OB}$ as sides; its direction is shown in Fig. 1. The force $\boldsymbol{R}$ is called the resultant of the forces $\boldsymbol{F}_1$ and $\boldsymbol{F}_2$. Expressed in symbols, $\boldsymbol{R} = \boldsymbol{F}_1 + \boldsymbol{F}_2$, where the addition is understood to be in the geometric sense described above. This is the first principle of statics, known as the parallelogram law of forces.




*Figs. 1-4—Method of determining the resultant of two or more forces passing through a common point*

**Resultant Force.** Instead of constructing the parallelogram *OACB*, the direction and the magnitude of the resultant $\boldsymbol{R}$ can be obtained by constructing a triangle *OAC*, formed by shifting the vector $\boldsymbol{F}_2$ parallel to itself until the initial point $O$ of the vector $\overrightarrow{OB}$ coincides with the terminal point $A$ of the vector $\overrightarrow{OA}$. Clearly, the closing side of the triangle *OAC* has the length of the direction of the vector $\boldsymbol{R}$ (Fig. 2). This procedure of obtaining the resultant can be generalized in an obvious way to obtain the resultant of a system of forces $\boldsymbol{F}_1, \boldsymbol{F}_2, \ldots, \boldsymbol{F}_n$, all of which are applied at the same point $O$ of the body. Thus, if the system consists of four forces shown in Fig. 3, one can obtain the resultant of the forces $\boldsymbol{F}_1$ and $\boldsymbol{F}_2$, add this result to the force $\boldsymbol{F}_3$, and so on, to obtain the resultant $\boldsymbol{R}$. The resultant $\boldsymbol{R}$ found graphically is represented by the closing side of the force polygon *OABCD* (Fig. 4).

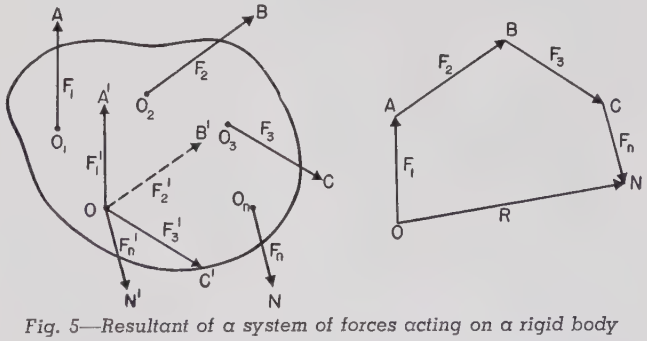
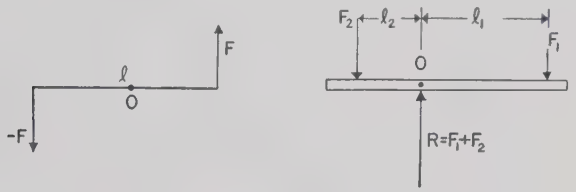



*Fig. 5—Resultant of a system of forces acting on a rigid body*

The definition of the resultant force will be extended to a system of forces $\boldsymbol{F}_1, \boldsymbol{F}_2, \ldots, \boldsymbol{F}_n$, acting on a rigid body, and having different points of application, $O_1\ O_2, \ldots, O_n$. A point $O$, called the point of reduction, is chosen, and there a system of concurrent forces is constructed whose directions and magnitudes are the same as those of $\boldsymbol{F}_1, \boldsymbol{F}_2, \ldots, \boldsymbol{F}_n$. The resultant $\boldsymbol{R}$ of these concurrent vectors, that is, the vector represented by the closing side of the polygon of forces, is called the resultant force acting on the body (Fig. 5). Clearly, the vector $\boldsymbol{R}$ does not depend on the choice of the point of reduction. If the length of the vector $\boldsymbol{R}$ is not zero, the body cannot remain at rest. For, in accordance with Newton's second law of motion, any body acted on by an unbalanced force will move with an accelerated motion. It follows that a

necessary condition for equilibrium of a body is that the resultant of all forces applied to the body vanish. This condition, however, is not sufficient; that is, the resultant of applied forces may vanish, and yet the body may not be at rest.

As a simple, important illustration of this circumstance consider a thin, rigid rod of length $l$ whose weight is negligible in comparison with the magnitude of the forces applied

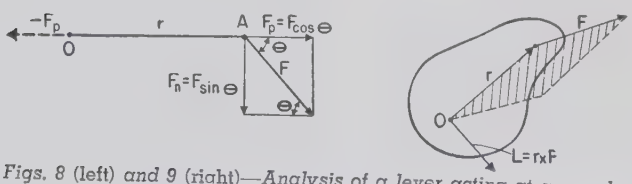



*Figs. 6* (left) *and 7* (right)—*Illustration of a couple, and of a lever, respectively*

to it. Let this rod be subjected to a pair of forces $\boldsymbol{F}$ and $-\boldsymbol{F}$ equal in magnitude and opposite in direction, and applied at the ends of the rod as shown in Fig. 6. The resultant $\boldsymbol{R}$ in this case is $\boldsymbol{F} - \boldsymbol{F} = 0$, but the rod will not be in equilibrium. It is clearly evident that it will turn about the mid-point $O$ of the rod. A system of two equal and oppositely directed forces, not acting in the same straight line, forms a couple, the magnitude of which can be taken as the product of the magnitude of $\boldsymbol{F}$ by the length of $l$ of the lever arm. The significance of this choice of measure can be seen from the following considerations, which illustrate the principle of the lever as deduced by Archimedes and which give rise to a condition of rotational equilibrium. Consider a light, uniform, rigid rod pivoted at the point $O$, subjected to the action of the force $\boldsymbol{F}_1$ applied at a distance $l_1$ from the pivot, as shown in Fig. 7. Under the action of the force $\boldsymbol{F}_1$ the rod will turn about the point $O$. It is suggested by direct experiments that the rotation of such a rod may be prevented by applying a force $\boldsymbol{F}_2$ at a distance $l_2$ from the pivot, of such a magnitude that $F_2\, l_2 = F_1 l_1$.

The number of ways in which the rotation may be prevented is infinite, and the essential thing is to choose the forces $\boldsymbol{F}$ and the points of application so that the product of the lever arm $l$ and $\boldsymbol{F}$ is equal to $F_1 l_1$. This statement embodies the law of the lever.

The equilibrium of the system is readily explained. The action of the forces $\boldsymbol{F}_1$ and $\boldsymbol{F}_2$ on the pivot gives rise to a reaction force $\boldsymbol{R}$, acting on the pivot at $O$ and directed oppositely to the forces $\boldsymbol{F}_1$ and $\boldsymbol{F}_2$. In accordance with the action-reaction principle in mechanics, the magnitude of $\boldsymbol{R}$ is equal to the sum $\boldsymbol{F}_1 + \boldsymbol{F}_2$. Thus the resultant of all forces acting on the system $\boldsymbol{F}_1 + \boldsymbol{F}_2 + \boldsymbol{R} = 0$, so that the necessary condition for equilibrium noted above is fulfilled. The force $\boldsymbol{F}_1$ gives rise to a clockwise torque, or moment, of magnitude $F_1\, l_1$ about the point $O$, which is balanced by the counterclockwise moment $F_2\, l_2$ of the force $\boldsymbol{F}_2$. It appears that to




*Figs. 8* (left) *and 9* (right)—*Analysis of a lever acting at an angle, and use of vector products, respectively*

prevent the rotation, the algebraic sum of the moments must vanish if the body is to be in equilibrium. If the force $\boldsymbol{F}$ acts at angle $\theta$ with the rod as shown in Fig. 8, this force can be thought of as being the sum of two component forces, one of which, $\boldsymbol{F}_p$, of magnitude $F \cos \theta$, acts parallel to the rod and is balanced by the reactive force $-\boldsymbol{F}_p$ applied to the pivot, and the other, $\boldsymbol{F}_n$, of magnitude $F \sin \theta$, is directed at right angles to the lever arm. In this case, the torque of the force $\boldsymbol{F}$ will have the magnitude $F\, l \sin \theta$, and it can be counterbalanced by any force giving rise to a counterclockwise moment of magnitude $F\, l \sin \theta$.

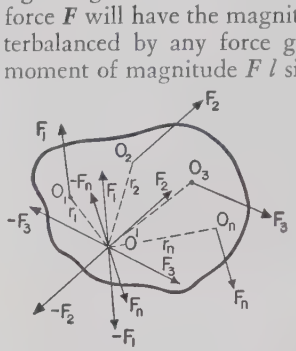



*Fig. 10*—CONDITION OF EQUILIBRIUM IN A RIGID BODY

In order to take proper account of the signs of the moments when a large number of forces act on a body, the moment of force $\boldsymbol{F}$ about any point $O$ of the body (Fig. 9) can be regarded as a vector $\boldsymbol{L}$ which is the vector product $\boldsymbol{r} \times \boldsymbol{F}$ of the position vector $r$ and the force $\boldsymbol{F}$. Thus $\boldsymbol{L} = \boldsymbol{r} \times \boldsymbol{F}$. If a rigid body is acted on by a system of forces applied at the points $O_1, O_2, \ldots, O_n$ (Fig. 10), then it is easy to show that for any point $O'$ of the body, the given system can be replaced by a single force $\boldsymbol{R}$, the resultant of $\boldsymbol{F}_1, \boldsymbol{F}_2, \ldots, \boldsymbol{F}_n$, and a couple $\boldsymbol{L}$ whose moment is equal to the sum $\boldsymbol{r}_1 \times \boldsymbol{F}_1 + \boldsymbol{r}_2 \times \boldsymbol{F}_2 + \ldots + \boldsymbol{r}_n \times \boldsymbol{F}_n$. This fact follows almost immediately if one applies at point $O'$ a system of pairs of equal and oppositely directed forces $\boldsymbol{F}_1, -\boldsymbol{F}_1; \boldsymbol{F}_2, -\boldsymbol{F}_2; \ldots \boldsymbol{F}_n, -\boldsymbol{F}_n$, which obviously do not alter the state of a rigid body.

Now the force $\boldsymbol{F}_1$ applied at $O_1$ and the force $-\boldsymbol{F}$ applied at $O'$ form a couple whose moment about $O'$ is $\boldsymbol{r}_1 \times \boldsymbol{F}_1$. Similarly, the forces $\boldsymbol{F}_2$ and $-\boldsymbol{F}_2$ acting at $O_2$ and $O'$, respectively, give rise to a couple of moment $\boldsymbol{r}_2 \times \boldsymbol{F}_2$, and so on. The resultant moment $\boldsymbol{L}$ of the couples so formed about the point $O'$ is equal to $\boldsymbol{L} = \boldsymbol{r}_1 \times \boldsymbol{F}_1 + \boldsymbol{r}_2 \times \boldsymbol{F}_2 + \ldots + \boldsymbol{r}_n \times \boldsymbol{F}_n$. The remaining forces $\boldsymbol{F}_1, \boldsymbol{F}_2, \ldots, \boldsymbol{F}_n$ acting at $O'$ add up to give the resultant $\boldsymbol{R}$. Now, unless $\boldsymbol{R}$ and $\boldsymbol{L}$ vanish, the system will not be in equilibrium. Hence, the vanishing of both $\boldsymbol{R}$ and $\boldsymbol{L}$ is a necessary condition of equilibrium. This condition can also be shown to be sufficient for equilibrium if the body is initially at rest. Thus, the problem of equilibrium reduces to two analytic conditions $\boldsymbol{R} = 0$ and $\boldsymbol{L} = 0$. These equations give the mathematical statement of the principle of equilibrium.

The theory of statics is used extensively in the analysis of forces acting on structures. In case of continuous distribution of forces, the sums giving rise to the resultant moment $\boldsymbol{L}$ and the resultant force $\boldsymbol{R}$ are replaced by the corresponding integrals $\boldsymbol{L} = \int (\boldsymbol{r} \times \boldsymbol{F})\, dm$ and $\boldsymbol{R} = \int \boldsymbol{F} dm$, in accordance with the usual procedures of the integral calculus. *See also* MECHANICS; STRUCTURE ANALYSIS. I. S. S.

**STATIONS OF THE CROSS** (Way of the Cross), (1) representations of (usually) fourteen scenes in the Passion of Christ, and (2) a special devotion performed in connection with these. The practice of this devotion, traced to about the fifteenth century and connected with pilgrimages to Jerusalem, became general in the seventeenth century, many indulgences being attached thereto by the popes. The devotion consists normally in passing from station to station while meditating on the sufferings of Christ; set prayers are sometimes recited and the *Stabat Mater* sung. N. J. T.

**STATISM,** a term, until recently an obsolete synonym for statecraft, that has come into use, notably since the 1930's, as a general expression for governmental concern with, and involvement in, the economic and business activities and welfare of the people. Although *statism* also implies growing dominance of the political power in other aspects of life, the controls, interference, and proprietary activities characterizing it have their principal impacts upon the means by which nations gain their livelihood.

Inevitably, however, involvement of government, or the state, in oversight of the nation's economy puts its stamp upon attitudes and outlook broadly affecting society as a whole. The repercussions of statism in its various forms are on an international, as well as a national, scale. Pouring economic and business activity into molds of political policy enhances the economic importance of national boundaries and complicates international diplomacy to the extent that transactions, otherwise the primary or sole concern of individuals or of business groups, become at least in part the responsibility of governments. A great growth of such responsibility has characterized the decades since the outbreak of World War I. In fact, the mid-twentieth century period finds statism so pronounced and widespread that many parallels suggest themselves with the programs of eighteenth century and earlier mercantilism, which were largely swept away by the rising tides of the Industrial Revolution.

In general, there may be distinguished three levels of political or government involvement in economic and business activities. These levels, or stages, imperceptibly merge into each other. They represent no clear-cut pattern of historical evolution; in fact, they often co-exist within the economy of a single country, and they are coterminous in Europe and elsewhere. Nevertheless, these levels of governmental intervention do serve to point up the possible pattern of progression (or of retrogression, depending upon the observer's outlook) from a minimum of political interference, often referred to as "laissez faire" ("let things alone," "keep hands off"), to the complete absorption of the people into the state, or totalitarianism in its several forms.

On the *first* of these stages of political involvement in business, the state concerns itself with establishing or shoring-up the essential national foundations of economic activity, and with helping to create and enforce the "rules of the game." Numerous and necessary as are the points of contact between agencies of government and persons engaging in economic activities, the scope of government on this first level is wholly compatible with an economically dominant private capitalism. It is the nearest feasible approach to a laissez-faire state of affairs in the relations of business and government.

The ideals of freedom and equality expressed in the Declaration of Independence and of freedom expressed in the Federal Constitutional Bill of Rights are epitomized in the phrase "life, liberty, and property," which are not to be taken "without due process." The very existence of private property, however, which was closely associated with the other freedoms by the Republic's founding fathers, is dependent upon a complicated network of laws, regulations, and court decisions underlying contractual relationships. Hence it may be said that government is necessarily an integral part of business. The great question is how far governments need to be involved in order to serve best the interests of society in general.

On the *second* level of governmental involvement in economic activity, the state assumes a supervisory role without dominating or actually taking over the functions of private enterprise. Here, two stages may be broadly distinguished; one, that of predominantly *indirect* controls; two, that of *direct* controls, generally accompanied by, and often supplementing, indirect controls.

Such controls, exerted by agencies of government in many directions and by many means, will be illustrated below. They arise in part from theoretical appraisal of the deficiencies of private enterprise capitalism and from experimentation in political intervention to which this gives birth. In part they arise from efforts, studied or sporadic, to meet existing emergencies by governmental action "from above" based upon the sovereignty of the state, which as a last resort can add the sanction of physical force to the economic and moral sanctions that undergird most social activity. The direct and indirect controls characterizing this second level of statism do, however, all imply the inability of private enterprise, when left largely to its own devices, to serve adequately the nation's needs. The direct controls take over some functions, or notably impinge upon some prerogatives, of business and labor management.

The *third* level of state participation in economic and related social activities is that of direct and proprietary business activity, or "government trading." This replaces, or at least takes the place of, private enterprise capitalism. It may spread over only part of the nation's economic activity or may completely engulf it. It may be the result of *evolutionary* or *revolutionary* process, or of both, if any clear-cut distinction can be made between them. Government trading on a large scale (state socialism) coexists in some countries with a considerable measure of personal freedom, that is, with the political liberties and basic human rights of individuals and minorities, without which democracy as understood in the West is inconceivable. When state ownership and management absorb the bulk or all of economic activities, as in countries behind the Iron Curtain, there results a totalitarianism which completely subordinates the individual to the dictatorially led and all-powerful government.

Historically associated with these three levels of governmental relationship to the economy are three schools of thought, or more accurately, three approaches to the economic analysis of human behavior. These are perhaps best exemplified in Adam Smith, as a founder of classical economics; in Karl Marx as the chief intellectual architect of socialism and the class struggle; and in John Maynard Keynes as the most influential exponent in our times of the responsibility of the state in controlling business fluctuations and in preventing underemployment. In noting these associations, however, it would be misleading wholly to identify these thinkers with the attitudes and rationalizations of government-business relationships on the different levels just described. It would equally be a mistake to ignore the often conflicting emphases and theories among the many writers who in general view the situation from one or another of these three vantage points.

Thus, Adam Smith's *Inquiry into the Nature and Causes of the Wealth of Nations,* published in 1776, took an optimistic view of the outlook for mankind, provided the state controls over commerce and handicrafts that had been for centuries typical of mercantilism were relaxed and scope given for individual initiative and division of labor in exploiting a bountiful nature. On the other hand, his immediate successors among the classical economists, like Ricardo,

stressed the niggardliness of nature; and, like Malthus, the tendency of population growth to press against means of subsistence—thus bringing down upon the new doctrines of economics the characterization of "the dismal science."

Nevertheless, a characteristic attitude of these thinkers and their followers may be summed up in a virile opposition to over-meddlesome governments, so far as the rising tide of industrial and commercial activity was concerned, and a faith in reasonably just output and distribution of wealth, provided the people were allowed scope for exercising their natural rights, and regulation of economic activities were left to the market places. The application of these ideas in the field of international commerce, as promoted by the Manchester School in England, had a great deal to do with the establishment of comparatively "free trade" between the British Empire and the rest of the world during a considerable part of the nineteenth century and until the global wars of the twentieth century undermined the freely-operating international gold standard and the multilateralism and nondiscrimination in exchange of commodities which accompanied it.

A far different philosophical approach, also rooted in the dynamism of the industrial revolution, has led in the opposite direction of fastening upon men the tentacles of governmental bureaucracy in dictatorially dominated, all-powerful totalitarian states. Karl Marx and Friedrich Engels brought out their *Communist Manifesto* in 1847, and the former's *Das Kapital* (Vol. I) appeared in 1867. With so-called "Utopian Socialists," these writers held that labor was the creator of all wealth and was continuously exploited by the toll of profits, rents, and interest exacted from production by private-enterprise capitalism.

Marx saw in this the inevitable downfall of capitalism, as its products, he argued, could not be fully absorbed by the masses who produced them. Cataclysmic business cycles would be followed by revolutionary expropriation of the hitherto privately-owned means of production and exchange. This, Marx reasoned, would end the class struggle by ushering in a classless society. Communist revolutionaries would thus act as midwives of destiny, hastening the dictatorship of the proletariat, a transitional period to be followed by a withering away of the state.

It is obvious that Communist Russia and its satellites behind the Iron Curtain show no evidences of any withering away of the functions and controls of government. The seemingly permanent, rather than merely transitional, dictatorship is, of course, to be explained in wider terms than Marx's mid-nineteenth century theories, which were developed against a background of labor exploitation, in the days before factory codes, child labor laws, recognized collective bargaining, and more equitable sharing of fast increasing production eased the lot of the workers. It must in part be explained by the new dispensation of Marxist theory originating in Lenin, Stalin, Trotsky, and other Communist doctrinaires; by political and economic conditions peculiar to Russia; and by the continuing aggressive thrusts of age-long Russian imperialism.

Wth the publication, in 1930, of *The General Theory of Employment, Interest and Money* by the late Lord Keynes, came the most reasoned and the most convincing statement of the case for governmental intervention as a means of saving private enterprise capitalism from its alleged inherent weakness of recurrent depression and underemployment. So great has been Keynes' influence upon current economic thought that "Keynesianism," which to a certain extent mirrored the business failures and unemployment of the 1930's, has gained a following among contemporary economists who, in their refinements and new applications assume for it a more than passing validity.

Since the ideas of Keynes have also taken hold in government circles and have given theoretical justification for certain aspects of present-day statism, the briefest résumé of his system of thought is in order. Keynes maintained that as income increases, the tendency to save rises at the expense of the tendency to consume. Orthodox economic reasoning had taken the view that failure of consumers to use up all their income would not bog down demand for the products of industry, because reductions in interest rates, resulting from a higher rate of savings, would make more attractive to business men the borrowing and investment of these savings in purchase of capital goods, in the employment of labor, and in otherwise facilitating production and its accompanying demand.

Keynes, however, denied the role of interest rates in equating the demand for, and supply of, consumer savings or capital. Interest was for him largely an expression of "liquidity preference," i.e., the extent to which individuals and business firms prefer cash in hand, including bank demand deposits, to less liquid assets. This liquidity preference would not permit low enough levels of interest rates to attract investment in business ventures at a time when, as Keynes saw it, the "marginal efficiency" of capital was declining. Hence thrift might actually be dangerous to economic stability, since it could weaken consumer demand without a compensating strengthening of producer demand.

Granted these hypotheses of Keynesian logic, the result, short of state intervention, would appear to be a slowing up of production, a consequent unemployment or underemployment of labor, and a fall in income to levels at which the resulting rising tendency to consume would take off the market the smaller volume of products, and the diminishing tendency to save would bring savings into line with the effective demand for capital. These disturbing shorter-term maladjustments between savings and investment tend toward the establishment of equilibrium, under private enterprise capitalism, at rates of production and marketing permitting less in the way of employment and income than the economy could and should provide.

Perhaps it would not be too facetious to say that here is where the tenets of Keynesianism call in the state to help set right these assumed inherent deficiencies of private enterprise capitalism, in somewhat the same manner as ancient Greek dramatists introduced gods by special stage machinery to straighten out the affairs of men at critical junctures. Alarmed by notions of a slowing-up, or a "mature" economy, and impressed by the Western European and American trends, noticeable during the 1930's, toward an aging and stationary population, numbers of economists, business men and politicians have subscribed to a program of governmental injections of credit and purchasing power into the body economic as a normal and dependable means of shoring up and stabilizing the economy.

These expressions of statism, which spring from reliance upon government to mitigate business fluctuations and to promote full employment, generally take the form of indirect controls. Thus, unbalanced budgets, by sponging up, through taxes, less in purchasing power than is released by government spending are relied upon as a shot in the arm for faltering employment. By the same token a surplus in the national budget is advocated to poultice a boom, though this kind of treatment runs up against the natural

political impulse to spend freely and tax lightly in good as well as bad times. The central banks, mostly governmentally controlled, ease and tighten credit with the same objectives in mind. The state sets up its own lending and financing agencies more immediately to affect the tempo of economic activity. Substantial programs of public works are carried out or held in reserve, as the case may be.

Such forms of economic statism necessarily rely upon tight governmental control of the nation's money and of its central banks. This is, of course, also true of socialistic and totalitarian regimes. Inconvertible currencies may be expanded or contracted as tools of control at the will of the political regime, whose obligations may be bought by the banks to bolster their market values and to keep interest rates at artificially low levels. This is really a means of converting government debt into current purchasing power. It frees the regime from complete dependence upon taxes and from controls over fiscal and monetary policies of the kind exerted by the people of gold-standard countries prior to the 1930's, when their confidence in the currency could be put, at any time, to the acid test of demand for redemption in the precious metal. In this connection can be noted the significance of the 1951 agreement between the Treasury Department and the Federal Reserve Board, freeing the latter of any obligation to keep U.S. government bonds at parity or above and subordinating the Treasury's desire for minimum interest rates to the general credit needs of a private enterprise economy.

The international repercussions of statism stem principally from substitution of governmental action or responsibility in place of the transactions of innumerable individuals and going concerns freely operating, both domestically and in foreign countries, in industry, commerce, investment and travel. Free operation characterized the vast expansion of production and trade in the nineteenth and early twentieth centuries; government control has typified the era of the two world wars.

In fact, restrictions currently imposed by governments, from a variety of needs and purposes, upon foreign exchange, imports, and exports (tariffs, quotas, preferences, and bounties), sources and destinations of commodities, international allocations of raw materials, shipping, investments, movement of persons, prices, collections, subsidies, buying in the lowest markets, selling in the highest markets, and so on, have many points of resemblance to the mercantilism of earlier centuries. They may, therefore, be considered a return to methods of the past.

The nationalism which accompanies and partly accounts for these various manifestations of statism is in turn aggravated by it. Thus, a continuing government oversight of the economy leads to partial insulation from possibly disturbing influences originating in other countries. The indirect controls in the political storehouse of economic weapons are often supplemented or replaced by such direct controls as wage and price stabilization through ceilings, floors, parity prices, and other devices mentioned above. State socialism, with its responsibilities of industrial ownership and management, tends to be more nationalistic than the private enterprise capitalism, which it has traditionally denounced for imperialism. The totalitarian regimes of Soviet Russia and her satellites will, of course, brook no interference from abroad.

Thus, statism shows certain tendencies toward self-perpetuation. The longer a country's monetary and credit system has been politically manipulated to centrally dominate the economy, the more difficult is its recovery of a flexible response to the commercial and industrial needs of the nation's business. Nationalism, it may be repeated, increases the economic significance of political frontiers. Nationalism enhances the struggle for self-sufficiency, which in turn spreads the threat of war, feeds the fires of nationalism, and, thereby, completes the vicious circle. Controls, both direct and indirect, call for continuous extension in the interests of justice and effectiveness. Instability seems to haunt hybrid or half-way systems between direction of the economy by market prices, and direction from above by government.

The principal origins of statism in our time now seem clear. They may be briefly summarized as follows: 1. The impacts of war, of the aftermath of war, and of the imperatives of defense mobilization; 2. The efforts to implement certain theories, or ideologies—from state socialism in a democratic context, to monopolistic government trading within a totalitarian framework; 3. The application of governmental remedies to the economic problems of unemployment and disturbing business fluctuations; 4. Processes of drift and evolution which are not immediately associated with any of the foregoing.

The purposes served, or sought to be served, in varying degree by the many forms of governmental control, intervention, and ownership known as statism range from acting umpire, setting the rules of the game, and conserving and developing the nation's resources in attempts to strengthen competitive private enterprise, on the one hand, to guarding the international balance of payments, demonstrating the superiority of government enterprise, and, in totalitarian systems, converting the nation into an armed camp fired by fears and hatreds directed toward foreigners and minorities on the other.

In this connection it should be borne in mind that overlordship by the state which justifies the term "totalitarianism" may come about without replacement of private enterprise capitalism by direct and proprietary governmental business activity. Nazism, or the rule of "the National Socialist German Labor Party," from the early 1930's until the end of the Second World War; and Fascism in Italy from the early 1920's until the downfall of Mussolini are the best examples of this. However, although "Communism," or "Sovietism," is assumed to be of "the Left," and "Nazism" and "Fascism," of "the Right," there is here, in some respects, a case of extremes meeting—if in fact they are extremes at all.

Thus in all these authoritarian systems the citizen is exhorted and expected to identify himself with the national group, which is also identified with the existing regime, or government. An integral part of the regime is the unitary "party"—Communist, Fascist, or Nazi, as the case may be. The domineering party is in turn dominated by a dictator, clique, or junta, who maintains himself, or which maintains itself, in power by rigorous control of electoral candidacy lists confined to followers of the "party line." Despite the preservation of the institutions of private property in totalitarian systems of the "Right," such as Nazism and Fascism, the initiative, responsibility and authority of the individual citizen and of the business entrepreneur are definitely circumscribed by and subject to the overriding will of the dictatorship.

In Germany, for instance, Hitler and his Nazi high command became economic as well as political dictators. It has been pointed out by competent observers close to the scene that, as a means of socializing the whole apparatus of production and distribution, including agriculture as

well as industry, the pervasive governmental controls under Nazism proved more effective than expropriation. The program of general governmental centralization and domination, embodied in the aggressive military build-up and in other deficit-financed attacks upon mass unemployment went far beyond the party program announced in 1920, Point 13 of which ("Nationalization of all big incorporated business 'trusts' . . .") was transcended in every field of economic and social activity, *de facto,* if not *de jure.* The substance of the institution of private property was destroyed; only the shadow remained.

The challenge, thrown by Nazi militants at German Socialist parties during the time of the Weimar Republic revealed, in such slogans as abolition of unearned incomes, and "breaking the bondage of interest slavery," that imitation which is the sincerest flattery. In some respects Nazism may be considered a sinister lineal descendant of the state socialism which, originating and always finding a spiritual home in Germany, never repudiated the institutions of family and private property, and went far in encouraging the protective legislation and the benevolent paternalism espoused by Bismarck and his successors.

In its deviations from, rather than in its espousal of, traditional socialist doctrines, Nazism showed a fundamental kinship with Fascism, whose origins, also in part socialistic, were ideologically related to French (revolutionary) Syndicalism and to British Guild Socialism. The collectivist doctrines of Hitler, Mussolini, and their polemicists found support in the early twentieth century wedding of nationalism and socialism in the writings of Friedrich Naumann, who envisaged incorporation of the workers into the state as a means of countering the Marxian class struggle; and in the gloomy philosophy of Oswald Spengler, whose dim view of democracy and liberalism suggested the alternative of a contemporary Caesar.

As against the mysticism, romanticism, and anti-intellectualism of the Nazi movement, however, with its anti-semitism and racialism (ideas partially attributable to Adam Müller and Houston Stewart Chamberlain respectively), Fascism tended toward realism and empiricism in its years of initial power. It later jelled into an elaborate system of federation, confederation and guild (or "corporazion") organization of workers and employers, in contrast with the opportunistic, heavy-handed, and rather inchoate strategy of the Nazi dictatorship.

Fascism borrowed from Syndicalist beliefs in functional economic organization, in the impotence of parliamentary democracy, in the responsibility of occupational groups for the reorganization of government and society, and in the mission of the élite in guiding the entire process. Drawing upon its sturdy Italian nationalism, however, Fascism sought to strengthen rather than destroy the state, and to fasten its centralized controls upon all productive groups. In these latter respects, at least, it departed far from the ideology of Georges Sorel who, among the most prominent of French Syndicalist writers, repudiated political parties and the bourgeois state and handed the revolutionary role wholly to the working proletariat.

In emphasizing the dominance of central government the Fascist regime also parted company with the doctrines of Guild Socialism, a milder and more evolutionary philosophy than Syndicalism. This movement, in which G. D. H. Cole, R. H. Tawney, and a number of other prominent English writers set the pace during the first two decades of our century, called for largely self-governing productive groups which, through cooperation, would create a "functional democracy" with workers controlling industry. The Fascist conception, on the contrary, was the Guild, or Corporative organization of the state as a means of asserting governmental supremacy in all directions—suppressing local autonomy and subjecting men and property to the overriding requirements of national policy as determined from above.

Reverting, then, to the earlier comparisons drawn among these totalitarian regimes, whether based upon nationalization or not, it is fundamental to understand the relative impotence of the voters, the arbitrary state controls, the leadership principle, the lack of representative and free labor unionism, and the insecurity of individuals and minorities which characterize them all.

Descriptions of statism as it exists in different parts of the world today would far transcend the limits of any article. It is possible, however, to distinguish in general terms among countries like the United States, Canada, and certain Western European nations, where private enterprise capitalism dominates the economic scene; countries like Great Britain and the Scandinavian group which follow the "middle way" of mixing state socialism with co-operative undertakings and privately capitalized enterprise; countries like Russia and her satellites which subordinate the individual to the monopolizing and all powerful government; and countries like India and Pakistan whose undeveloped economies and paucity of capital, skilled labor, and know-how seem to call for government guidance and international aid in raising the people's living standards. These latter countries obviously fall into none of the earlier classifications.

In gauging the force of statism in any country it is necessary to appraise the role played by government against the background of national resources and historical economic evolution. The American traditions of free enterprise were greatly fortified by a seemingly limitless frontier, a rapidly growing but never excessive population, and a heritage of political freedom and egalitarian philosophy. Even in the United States, however, ambitious government planning on the national as well as the state level had much to do with shaping the national economy, from Alexander Hamilton's protective tariff to the state and Federal boosts given railways, highways, canals, banks, prospectors, homesteaders, and others.

In most European countries, as elsewhere, governments have historically helped to finance and have often directly participated in economic activities here traditionally reserved for private enterprise. It is to be expected that this pattern will be repeated and intensified in countries now economically struggling to their feet. At the same time, governments currently plagued with balance of payments difficulties, with depressed standards of living, with the dangers of war, or with the challenge of undeveloped resources are in some notable instances increasingly cooperating among themselves, and with private enterprise, in laying the foundations of a better order. International technical aid, the General Agreement on Tariffs and Trade, the western European Coal and Steel Community, the Colombo Plan, and the European Payments Union are steps in this direction.

This realistic rather than doctrinal approach in meeting the world's ills may go far toward providing common meeting ground for advocates of "laissez faire" and the devotees of statism. In any case, it helps focus attention upon the problems of the peoples, which too often are obscured by the maneuvers of the powers. L. R. R.

**STATISTICAL MECHANICS.** *See* KINETIC THEORY AND STATISTICAL MECHANICS.

**STATISTICS,** the science of classification and manipulation of data in order to draw inferences.

The basic materials with which a statistician operates are numbers. Sometimes these numbers arise from counting, and sometimes they arise from measurement. Vital statistics such as the number of births and deaths or the number of marriages in a state in a given period of time arise from counting. Such numbers are usually called discrete data. In some situations, measurement comes from a scale; examples are length, weight, and time. Such data are usually called continuous, even though the measurements themselves can only be taken to a certain degree of fineness.

**Census.** There are two principal ways to gather data: by census or by sample. In either case, it is necessary to define the population or aggregate of objects under consideration. If one is interested in heights of people, for example, the population might be 20-year-old white males from California. Using the census technique, one would measure the height of every person in the defined population. Such a procedure would be costly and difficult to administer. Furthermore, a census of a large population is seldom complete. A more practical way to study the distribution of heights would be to take a carefully selected sample of say 2,500 males of the type specified.

**Sampling.** There are several kinds of sampling. One of the most frequently employed methods is random sampling. In random sampling, each element of the population has an equal chance of appearing in the sample, and the probability that an element appears in the sample is unaffected by the appearance of another element. Often stratified sampling is used either to get more accuracy than that supplied by random sampling, or to improve comparisons of groups within the population. In stratified sampling, the population is divided into levels or strata, usually on the basis of some variable other than that being measured. In the example on heights of men, one might take as a strata persons in cities of a population less than or equal to 25,000 and persons in cities of a population greater than 25,000. In general, if the population is of size $N$, and the $k$ strata of sizes are $N_1, N_2, \ldots, N_k$, where $N = N_1 + N_2 + \ldots + N_k = \Sigma Ni$, a stratified sample of $n$ is formed by taking a random sample of size $n_1$ from the stratum of $N_1$, a random sample of size $n_2$ from the stratum of $N_2$, and so forth such that $n = \Sigma n_i$. In stratified sampling, the $n_i$ are not necessarily proportional to the $N_i$, but an important special case of stratified sampling is proportional or representative sampling in which $n_i = N_i n/N$, $i = 1, 2, \ldots, k$. In systematic sampling, the elements of the population are arranged in an arbitrary order and numbered $1, 2, \ldots, N$. The desired sample size $n$ is selected and an integral interval $k = N/n$ is chosen. A random choice is made of the numbers $1, 2, \ldots, k$. Suppose it to be $l$. Then the sequence of elements numbered $l,\ l+k,\ l+2k, \ldots, l+rk$, $N-k < l+rk \leq N$, forms the systematic sample.

## DISTRIBUTIONS

It is often convenient to think of populations and samples as forming distributions. When dealing with discrete data, a frequency distribution gives the number of occurrences at each value of the variate being measured. In the case of measurement data, the variate is broken up into convenient-sized intervals, usually of equal length, and the frequency distribution gives the number of cases included in each interval. Such data are usually presented in the form of a graph such as a histogram, or tabularized as in the following example:

RECORD OF SOLDIERS DYING FROM KICKS OF HORSES

| *Number of Deaths in a Corps per Year* | *Frequency* |
|---|---|
| 0 | 109 |
| 1 | 65 |
| 2 | 22 |
| 3 | 3 |
| 4 | 1 |
| 5 | 0 |
| Total | 200 |

The first column of the table represents the number of deaths resulting from kicks by horses in one army corps in one year. The number of times exactly 2 deaths occurred is 22. This same information can also be shown graphically.

In mathematical statistics it is often necessary to deal with hypothetical distribution functions. If we have an integrable function $y = f(x)$ defined on the real axis, such that $\int_{-\infty}^{\infty} f(t)dt = 1$, $f(x) \geq 0$, $-\infty \leq x \leq \infty$, we may use it as a probability model. The probability of a value of $x$ in the interval $[u, v]$ is defined as:

$$P(u \leq x \leq v) = \int_u^v f(t)dt.$$

Under these conditions $f(x)$ is called a probability density function. The total area under the curve is unity, while the area over the interval $[u, v]$ is thought of as the long-run proportion of the times randomly chosen values of $x$ will fall in the interval under repeated sampling.

In the case of discrete data for which the variate takes on the values $x_1, x_2, \ldots$, the density function $y = p(x_i)$ is such that $\sum_i p(x_i) = 1$, $p(x_i) \geq 0$ for all $x_i$, and the probability of a particular set of $x_i$'s is merely the sum of the $p(x_i)$ over the appropriate set.

**Gaussian Distribution.** An important continuous distribution function is the general, normal, or Gaussian, distribution $y = (1/\sqrt{2\pi}\sigma)e^{-(x-a)^2/2\sigma^2}$. It is often used to approximate distributions of measurements in industry, psychology, education, and anthropology. Although it cannot be hoped that any kind of practical measurement will behave exactly like the mathematical model described by the normal distribution, it has been found to be extremely useful as an approximation to many physical phenomena.

**Binomial Distribution.** An example of a discrete distribution is the binomial distribution. If $p$ is the probability that a success occurs on a single trial, and $n$ is the number of trials, then the probability that exactly $x$ successes occur is:

$$P(x) = \frac{n!}{x!(n-x)!}\, p^x(1-p)^{n-x}, x = 0, 1, \ldots, n,$$

where $n! = n(n-1)(n-2) \ldots 3 \cdot 2 \cdot 1$, $0! = 1$. The binomial distribution is useful in dealing with genetic problems, public opinion polling, games of chance, or inspection of manufactured products. *Example:* If a fair die is thrown five times, what is the probability of no more than one ace appearing? Here, the probability of an ace appearing on a single throw is $p = 1/6$. The probability of no more than one ace is $P(0) + P(1) = (5!/0!5!)(1/6)^0(5/6)^5 + (5!/1!4!) \cdot (1/6)(5/6)^4 = 0.804$. This means that, in the long run, about 80 per cent of tosses of five dice will result in no more than one ace.

**Poisson Distribution.** Another useful discrete distribution is the Poisson distribution. If the average number of

occurrences of a phenomenon is $m$ per trial, the probability that exactly $x$ appear is given by:

$$P(x) = \frac{e^{-m} m^x}{x!} \quad x = 0, 1, 2, \ldots,$$

when the distribution is Poisson. The Poisson distribution is useful in dealing with events which happen in fixed intervals of time or fixed areas, such as the number of counts on a Geiger counter in a 15-second interval, the number of wireworms appearing in plots of ground six inches on a side, the number of phone calls in a given period, the number of bacteria in a certain area of a culture, and the number of accidents in a certain period of time.

## LOCATION PARAMETERS AND MEASURES OF VARIABILITY

**Arithmetic Mean.** In describing populations or samples, it is helpful to be able to present one or two numbers which provide the reader with a summary of the data at hand. Such numbers are often called descriptive statistics. The arithmetic mean or average is probably the best-known descriptive statistic. If we have a set of $n$ observed values $x_1, x_2, \ldots, x_n$, the arithmetic mean is defined as:

$$\bar{x} = (x_1 + x_2 + \ldots + x_n)/n = \Sigma x_i/n.$$

If the $n$ observations form the whole population, $\bar{x}$ is the population mean; while if they are a random sample from some population observations, $\bar{x}$ is the sample mean. In the latter case the sample mean is said to be an estimate of the true population mean. Usually the true population mean is unknown, and the sample mean is used to estimate it.

**Median.** Another useful descriptive statistic is the median. If the sample size is odd, the median is the middlemost observation, thus of 2.14, 3.29, 4.32, 4.40, 4.64, the number 4.32 is the median. If the sample size is even, the median is usually defined to be halfway between the two most centrally placed observations. If we add 4.93 to our previous set of five observations the median of the six observations is $(4.32 + 4.40)/2 = 4.36$. The median of a sample is an estimate of that position on a distribution such that 50 per cent of the distribution lies below it and 50 per cent lies above.

The mean and the median are called location parameters of a distribution function, because the shape of a distribution can remain unchanged even though its mean or median changes. Thus, if a distribution function is rigidly translated $x$ units to the right, $x$ units are added to the mean and median. For symmetrical distributions the mean and median are identical.

**Variability.** In addition to location parameters, it is useful to give some idea of the variability of the distribution. Perhaps the simplest measure of spread or variability is the range:

$$\mathrm{R} = \text{largest value} - \text{smallest value}.$$

In the tabular example which has been given, the number of deaths per corps per year ranges from 0 to 3, and so the range is 3. The range is particularly useful in connection with small samples, and it is widely used in industrial work.

**Standard Deviation.** For many purposes the standard deviation is a useful measure of spread. If we have observations $x_1, x_2, \ldots, x_n$, the standard deviation $s'$ is defined as the root-mean-squared deviation from the mean:

$$s' = \sqrt{\Sigma(x_i - \bar{x})^2/n}.$$

For many kinds of data met in practice, this statistic has the useful property that in large samples about two-thirds of the observations lie between $\bar{x} + s'$ and $\bar{x} - s'$, and about 95 per cent of the observations lie between $\bar{x} + 2s'$ and $\bar{x} - 2s'$. The more nearly normally distributed the data, the better these approximations hold.

If we have a theoretical probability distribution function $f(x)$, it can often be conveniently described by its moments. The $k$th raw moment of $f(x)$, if it exists, is defined by:

$$\nu_k = \int_{-\infty}^{\infty} x^k f(x)\,dx;$$

note that $\nu_0 = 1$, and $\nu_1 = a$ is called the population mean. The $k$th moment about the mean $a$, if it exists, is defined as:

$$\mu_k = \int_{-\infty}^{\infty} (x-a)^k f(x)\,dx.$$

We note that $\mu_0 = 1$, $\mu_1 = 0$, and $\mu_2 = \sigma^2$ is called the variance of the distribution, while $\sqrt{\mu_2} = \sigma$ is called the standard deviation of the distribution.

*Tchebycheff's Inequality* states that no matter what the distribution is, the total probability contained within the limits $a + \lambda\sigma$, $a - \lambda\sigma$ is:

$$P(a + \lambda\sigma \geq x \geq a - \lambda\sigma) \leq 1 - 1/\lambda^2.$$

It will be noted that this inequality says far less than the remark made earlier about the proportions lying within one or two standard deviations of the mean. However, this is a mathematically rigorous statement, and holds for pathological distributions, while the earlier statement is a rough guide for practical work in the presence of nicely distributed data.

In passing it should be noted that when the normal distribution is written

$$y = \frac{1}{\sqrt{2\pi}\sigma} e^{-(x-a)^2/2\sigma^2},$$

the mean or first moment is $a$, while the variance $\mu_2 = \sigma^2$. Consequently, for the normal distribution it suffices to specify the mean and variance to determine the distribution function completely.

Similarly, the binomial distribution $P(x) = (n!/x!(n-x)!)\, p^x (1-p)^{n-x}$ is completely specified by $p$ and $n$. The mean number of successes $a = np$, while the variance of the number of successes is $\sigma^2 = np(1-p)$.

The Poisson distribution $P(x) = e^{-m} m^x/x!$ is specified by one parameter $m$. The mean value of $x$ is $m$, and the variance of $x$ is also $m$.

In general, if there is a distribution function $f(x)$ *and* another function $g(x)$, there is said to be the expected value of $g(x)$ written:

$$E\Big[g(x)\Big] = \int_{-\infty}^{\infty} g(x) f(x)\,dx.$$

Consequently, the moments of a distribution function are often called the expected values of $x^k$, $E(x^k)$.

## POINT ESTIMATION

An important statistical problem is the estimation of parameters of distribution functions. The expression, point estimation, implies that a single number is offered as an estimate of a parameter rather than a range of values. When a range of values is offered as an estimate, one speaks of interval estimation.

In general, the sample mean $\bar{x}$ is an estimate of the population mean $a$. If one thinks of repeatedly drawing a sample of size $n$ from a distribution $f(x)$, then one may consider the resulting $\bar{x}$'s as having a distribution of their own, say $g(\bar{x})$. If $f(x)$ has mean $a$ and finite variance $\sigma^2$, then

$g(\bar{x})$ has mean $a$ and variance $\sigma^2/n$. In the special case where $f(x)$ is normal, it happens that $g(\bar{x})$ is also normal with the parameters just given. This property of the normal distribution is called the reproductive law.

The relation between the moments of $f(x)$ and $g(x)$ makes possible an important theorem which says that when the sample size $n$ increases without limit, the probability that $x$ will deviate from $a$ by more than a fixed absolute value $\epsilon$ tends to zero. When any statistic $\theta_n$ depending on the sample tends to a value $A$ in the manner just described of $\bar{x}$, one says that $\theta_n$ converges stochastically to $A$. Symbolically, $\theta_n$ converges stochastically to $A$ when:

$$\text{Probability } (|\theta_n - A| > \epsilon) \to 0 \text{ as } n \to \infty, \text{ for every fixed } \epsilon > 0.$$

The central limit theorem also follows from the conditions relating $f(x)$ and $g(\bar{x})$. This theorem states that for an arbitrary population with mean $a$ and finite variance $\sigma^2$, as $n$ increases without limit, the distribution of $z = (\bar{x} - a)\sqrt{n}/\sigma$ tends to a limit such that:

$$P(z \leq z_0) = (1/\sqrt{2\pi}) \int_{-\infty}^{z_0} e^{-t^2/2} dt.$$

This is the precise way to say that $\bar{x}$ is asymptotically normally distributed with mean $a$ and variance $\sigma^2/n$.

The central limit theorem plus practical investigations of the behavior of distributions of sample means drawn from rather unusual distributions give the statistician considerable confidence that means of samples as small as $n = 10$ are sufficiently nearly normally distributed for most purposes. This is one of the principal reasons for the importance of the normal distribution in statistics. A second reason for the importance of the normal distribution is that it is often possible to transform non-normally distributed data to approximate normality by such devices as taking the logarithms of the original observations. Third, many theoretical distributions approach normality when certain parameters become large or small; for example, when $m > 20$, the Poisson distribution is approximately normal with mean $m$ and variance $m$.

If from a distribution $f(x)$ a sample $x_1, x_2, \ldots, x_n$ is drawn and the statistic $\theta_n$ is constructed to estimate the parameter $A$, and it turns out that the expected value $E(\theta_n) = A$, one calls $\theta_n$ an unbiased estimate of $A$. It will be noted that $\bar{x}$ is an unbiased estimate of the mean $a$.

An unbiased estimate of the variance $\sigma^2$ of a distribution when the true mean is unknown is:

$$s^2 = \Sigma(x_i - \bar{x})^2/(n-1) = ns'^2/(n-1).$$

If among all possible asymptotically normally distributed statistics $\theta, \theta', \theta'', \ldots$ whose large sample expectations are $A$, there is one which has smallest variance, it is said to be the efficient statistic for estimating $A$. If $\theta$ is an efficient statistic and $\theta'$ some other statistic in the set defined, then the efficiency of $\theta'$ relative to $\theta$ is:

$$\text{efficiency} = \sigma_\theta^2/\sigma_{\theta'}^2.$$

For example, the sample mean $x$ from a normal distribution with variance unity is an efficient statistic for estimating $a$, the true mean; it has variance $1/n$. But the sample median is also an unbiased estimate of the mean $a$; it has asymptotic variance $\pi/2n$. The efficiency of the median is $2/\pi = .64$, which means in practice that for large samples only about 64 per cent as many observations are required to obtain the same precision from the mean as from the median. However, the median is much quicker to compute, consequently it will often be economically valuable to use a less efficient statistic, sacrificing precision for time. These considerations are particularly valid when observations are cheap and analysis of data costly.

## REGRESSION

When two variables are closely related, it is often possible to use one to estimate the other. An example of this kind of relation is given by the heights and the weights of people. From a person's height his weight may be estimated, not exactly, but more precisely than if the height were not known at all.

Very frequently it is possible to use a linear estimating function to estimate a variable $y$ from another variable $x$. In some cases when linear functions are inadequate, suitable curves can be found to assist in the estimation process. For many purposes, a curve or a line sketched through the plotted observed points $(x_1, y_1), (x_2, y_2), \ldots, (x_n, y_n)$ is adequate.

If a straight line of best fit is required, the least-squares criterion may be employed. The problem then is to find the line:

$$y = a + bx,$$

such that the sum of the squares of the vertical deviations, $\Sigma(y_i - a - bx_i)^2$, of the $y$ values from the line is a minimum. This criterion will be satisfied when the normal equations:

$$\Sigma y_i = na + b\Sigma x_i,$$
$$\Sigma x_i y_i = a\Sigma x_i + b\Sigma x_i^2,$$

are solved simultaneously for $a$ and $b$.

The least-squares criterion is purely arbitrary. Its use stems from the fact that most other criteria are mathematically difficult to work with, while the least-squares criterion in the case of linear estimation requires only the solution of linear equations to obtain the regression coefficients $a$ and $b$.

In general it may be required to estimate $y$ from several variables using a linear function on the form:

$$y = a_0 + \Sigma a_i x_i.$$

The solution for the $a$'s is similar to that for the two-variable case just described.

## CORRELATION

When two variables are statistically related, it is often useful to have a measure of their relationship. One measure of this relation is the product-moment correlation coefficient defined by:

$$r = \frac{\Sigma(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\Sigma(x_i - \bar{x})^2 \, \Sigma(y_i - \bar{y})^2}}.$$

The index $r$ runs from $-1$ to $+1$. When $r$ is $\pm 1$, the variables $x$ and $y$ are functionally related by a straight line. However $r = 0$ does not necessarily imply that there is no relation between the variables, because lack of linearity can cause this phenomenon.

If $x$ and $y$ are jointly bivariately normally distributed according to the density function:

$$f(x, y)\,dx\,dy = \frac{1}{2\pi\sigma_x\sigma_y\sqrt{1-\rho^2}} \times$$
$$e^{-\frac{1}{2(1-\rho^2)}\left[\left(\frac{x-a}{\sigma_x}\right)^2 + \left(\frac{y-b}{\sigma_y}\right)^2 - 2\rho\left(\frac{x-a}{\sigma_x}\right)\left(\frac{y-b}{\sigma_y}\right)\right]} dx\,dy,$$

then $r$ is an estimate of $\rho$, the population correlation coefficient. In this case if $\rho = 0$, knowledge of one of the variables will not assist in estimating the other.

It is an error to attempt to argue causation from the existence of high correlation coefficients. High correlation merely implies concomitant variation.

One of the principal uses of the correlation coefficient is in psychological and educational work with tests and measurements of human ability and behavior.

Sometimes it is useful to use the rank correlation coefficient $R$ to measure the association between two variables. This is particularly true when the data are known not to be normally distributed. The formula for the rank correlation coefficient is:

$$R = 1 - \frac{6\Sigma d^2}{n(n^2 - 1)},$$

where $n$ is the number of observations (pairs), and $d$ is the difference in rank of a pair of observations. Example: the ranked data on eight observations of $x$ and $y$ are (1,7), (2,6), (3,8), (4,5), (5,3), (6,4), (7,1), (8,2), where the largest value of $x$ is given rank 1, the next largest rank 2, . . ., and the smallest value rank 8, and similarly for $y$. Then $\Sigma d^2 = 158$, $n = 8$, $R = -0.78$. The minus sign implies that high ranks on $x$ are associated with low ranks on $y$, and vice versa.

## TESTS OF HYPOTHESES

Tests of hypotheses or significance tests as they are sometimes called, provide experimenters with techniques for deciding whether certain statements about populations are true or false. In the statement of a test, there are two hypotheses, the null hypothesis $H_0$, and the alternative hypothesis $H_1$. Observed data will generally not agree perfectly with the null hypothesis. The experimenter computes the probability of obtaining a discrepancy greater than or equal to the one observed under the assumption that the null hypothesis is true. If the probability of greater discrepancies is high, the tendency is to accept the null hypothesis and to reject the alternative hypothesis. If the chance of observing discrepancies as large as the one obtained is small, say 0.01 or less, the experimenter has this choice: (1) he may decide that the present data represent a rare event but that the null hypothesis is true, and that the discrepancy is merely due to sampling fluctuations, or (2) he may prefer to believe that the discrepancy observed is not due to chance, that such a rare event is too unlikely, and that he would rather believe that the null hypothesis is false and that the alternative hypothesis is true.

To make a test of significance more objective the experimenter usually decides on a significance level $\alpha$ in advance. He chooses $\alpha$ so that if discrepancies larger than that observed have probability less than $\alpha$, he will reject the null hypothesis; while if the discrepancy has probability greater than $\alpha$, he accepts the null hypothesis. The choice of the significance level $\alpha$ is arbitrary with the experimenter, but it is a fairly standard practice to choose one of the values 0.05, 0.01, or 0.001.

It is important to note that neither the null hypothesis nor its alternative can either be proved or disproved; they are merely accepted or rejected on the basis of the evidence supplied by computed probabilities.

As an example, suppose that a sample of size $n = 9$ is drawn from a normal distribution with variance $\sigma^2 = 36$. The null hypothesis $H_0$ is that the true mean $a \neq 100$, and the alternative hypothesis $H_1$ is that the true mean $a = 100$. The observed mean $\bar{x} = 105$. Let the significance level $\alpha = 0.05$. The mean $\bar{x}$ of a sample of $n$ drawn from a normal distribution with mean $a$ and variance $\sigma^2$ is again normally distributed with mean $a$ and variance $\sigma_{\bar{x}}^2 = \sigma^2/n$. Therefore, assuming $H_0$ to be true, the observed discrepancy is:

$$t = \frac{|\bar{x} - a|}{\sigma_{\bar{x}}} = \frac{105 - 100}{\sqrt{\frac{36}{9}}} = 5/2 = 2.5.$$

This means that $\bar{x}$ is 2.5 standard deviations away from the mean assumed true under the null hypothesis. Tables of the normal distribution indicate that the probability of deviations of more than 1.96 standard deviations in either direction from the mean is:

$$P\left(\frac{|\bar{x} - a|}{\sigma_{\bar{x}}} \geq 1.96\right) = 1 - \frac{1}{\sqrt{2\pi}} \int_{1.96}^{1.96} e^{-x^2/2}\, dx = 0.05.$$

Since the observed deviation of 2.5 exceeds the 1.96 criterion, the null hypothesis that the population from which this sample was drawn had mean 100 is rejected. In fact, the probability of a discrepancy exceeding the one observed is $P(t \geq 2.5) = 0.012$.

The variance of the population is likely to be unknown. In large samples ($n \geq 30$) the test function $t$ is therefore replaced by:

$$t = |\bar{x} - a| \sqrt{n}/s,$$

where $s^2$ is the estimate of $\sigma^2$ defined earlier. The rest of the procedure is identical.

For small samples ($n < 30$), to test this hypothesis it is necessary to consult a table of the $t$-distribution, which appears in most texts, with $n - 1$ degrees of freedom to find out the significance of the observed discrepancy. This is necessary because $\sigma$ is unknown and must be estimated from the sample.

A common problem is that of testing whether two samples could have come from populations with the same mean. If the observed means are $\bar{x}_1$ and $\bar{x}_2$, sample sizes $n_1$ and $n_2$, and sample standard deviations $s_1$ and $s_2$, this hypothesis can be tested for large samples by using the test function:

$$t = |\bar{x}_1 - \bar{x}_2| \Big/ \sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}},$$

and consulting a table of the normal distribution as before. Example: suppose $x_1 = 32.4$, $x_2 = 31.8$, $n_1 = 40$, $n_2 = 60$, $s_1^2 = 144$, $s_2^2 = 324$, then,

$$t = |32.4 - 31.8| / \sqrt{144/40 + 324/60} =$$
$$0.6/\sqrt{3.6 + 5.4} = 0.6/3 = 0.2.$$

The probability $P(t > 0.2) = 0.84$; consequently the null hypothesis of equal means would be accepted.

In applying tests of significance one must be careful not to confuse the concept of statistical significance with that of practical importance. A difference which could not have arisen by chance may still be so small as to be unimportant in practice, while a difference which is not significant may be of considerable practical importance if it really exists.

Many other tests of significance are available for testing hypotheses of various kinds.

## SPECIAL TOPICS

The special topics in statistics are extremely numerous. A few of the most important follow.

**Methods of Computation.** Most texts describe methods of computation which save time in the calculation of formulas of the sort presented here. Much time can be saved by grouping data and by rewriting formulas in forms suited

to the type of computation used (e.g. hand, slide rule, calculating machine, punched card, or electronic computor). Similarly, effective statistical work depends on presenting data or the implications of data effectively. Some of the best techniques are brief tables, bar charts, and color charts. A table or chart should not be too complicated.

**Design of Experiments.** The design of experiments is extremely important. Effective design requires an extensive knowledge of the topic under consideration as well as fundamental statistical knowledge. It is becoming increasingly common for authorities in various fields and for professional statisticians to co-operate in designing experiments.

**Analysis of Variance.** The signal success of the use of analysis of variance and analysis of covariance in agricultural experiments to discover the sources of variation in the yield of crops, suggested its use in other fields. This technique is becoming extremely important in investigations in education, psychology, biology, and industry.

**Non-parametric Tests.** Lack of normality of data has led to the development of nonparametric tests and nonparametric estimation. Such tests and estimates do not depend on the form of the original distribution functions. Tolerance limits developed by S. S. Wilks make it possible, in the absence of knowledge of the form of the distribution function, to assign limits on the basis of a sample. Limits assigned by this technique make possible statements of the type: at least 99 per cent of the density of a distribution is included between the limits 95 per cent of the time.

**Confidence Limits.** The technique of assigning confidence limits on the basis of a sample makes possible such a statement as: the true population parameter $A$ lies between $a$ and $b$. A certain preassigned percentage of such statements are true, say 95 per cent. It is not possible, of course, to know which statements are true and which false.

**Discriminant Function.** The discriminant function developed by R. A. Fisher is a device for classifying individuals into one of two populations, say races or species, on the basis of several measurements taken on each. Problems of th construction of index numbers, the analysis of economic time series, and population statistics loom large in economics and sociology. Some of the classic problems in time series are the discoveries of trends, the removal of seasonal variations, and the search for periodicities.

**Sequential Analysis.** During World War II, Abraham Wald made a significant contribution to the problem of testing hypotheses by developing the technique of sequential analysis. In sequential analysis one does not work with a fixed sample size, as in the tests described earlier. Observations are taken successively. After each observation one either (1) accepts the null hypothesis, or (2) rejects the null hypothesis, or (3) reserves decision for more evidence. This technique results in the use of a smaller average number of observations to reach a decision. Variations of this technique had been used earlier by anthropologists to decide when to stop collecting data, but the method had no satisfactory mathematical basis.

**Control Charts.** In industrial production, control charts developed by Walter A. Shewhart, are used to decide when to examine the production process. One standard procedure is to set up a chart with two parallel lines each three standard deviations from the mean of the process. At regular time intervals averages of five observations are plotted on the chart. If at any time a point falls outside the control limits the decision is made to search for maladjustments in the process. Lot-by-lot sampling inspection was developed by H. F. Dodge and H. G. Romig.

### HISTORICAL MATERIAL

Statistical inference frequently requires the use of mathematical models. Since many of these models require the use of the concept of probability, the histories of statistics and of probability have much in common. The mathematicians Blaise Pascal and Pierre de Fermat in 1654 worked on the theory of probability in connection with a gambling problem. Early definitions of probability were of the following type: If an event can occur in only one of a number of equally likely ways, $p$ of which may be considered favorable and $q$ unfavorable, then the probability of a favorable event is $p/(p+q)$. Thus, if a fair coin is thrown, the probability of a head is said to be ½, because the coin may come down either heads or tails. However, this definition of probability often presents difficulties because of the concept of "equally likely ways." Sometimes the possible ways appear infinite in number, and frequently it is impossible to evaluate the ratio $p/(p+q)$ in advance.

In 1711, a book by Jacques Bernoulli suggested that probability be applied to moral and economic questions. But Pierre de Laplace in the late eighteenth century made the first real applications in his writings on astronomy and probability. Later, Karl Friedrich Gauss gave considerable impetus to the study of errors as a result of his astronomical researches. Gauss derived the normal curve of errors, $y = e^{-x^2/2}/\sqrt{2\pi}$, and it is often called the Gaussian law, although A. DeMoivre and Laplace had investigated it earlier.

In the social sciences, statistics was advanced as a general technique of investigation by Francis Galton and L. A. J. Quetelet in the nineteenth century. Karl Pearson made substantial applications of statistics to biometry, anthropology, and sociology, and contributed extensively to mathematical statistics in the early twentieth century. Among other contributions, the methods of maximum likelihood and fiducial inference were developed by R. A. Fisher. Fisher also contributed substantially to the advancement of eugenics by application of statistical methods. About 1930, Walter A. Shewhart developed the control chart method of controlling the quality of manufactured products. This development is generally regarded as the first large-scale application of statistical techniques to mass production. In the field of mathematical statistics, Jerzy Neyman and Egon Pearson advanced the study of problems of testing hypotheses and confidence limits. F. Mo.

**STATIUS, PUBLIUS PAPINIUS** [ste′shiəs] (c. 45-95 A.D.), Latin poet born at Naples and poet at the imperial court of Domitian.

From 80 to 92 Statius composed his *Thebaid,* an epic poem of ten thousand hexameters, in twelve books. He also composed five books of *Silvae,* occasional poems rapidly written, nearly all in hexameter, and of various lengths. In antiquity Statius' fame rested largely on his *Thebaid,* but to modern taste the *Silvae* are more appealing. G. McL. H.

**STATUE OF LIBERTY.** *See* LIBERTY, STATUE OF.

**STATUTE OF WESTMINSTER,** an act passed by the British Parliament in 1931 which defined the position of the dominions within the British Commonwealth of Nations. Its chief importance was to give a formal and constitutional basis to relationships recognized by earlier understandings, particularly those of the Imperial Conferences of 1926 and 1930. These conferences, begun in 1887, were informal meetings of colonial and dominion representatives with representa-

tives of the British government to discuss matters of mutual concern. In 1926 W. L. Mackenzie King, Canadian prime minister, went to Great Britain intending to establish the autonomy of Canada. He was supported by South Africa and the Irish Free State. The Balfour Report, which summarized the conclusions of the conference, declared that the dominions were "autonomous communities within the British Empire, equal in status, in no way subordinate one to another in any aspect of their domestic or external affairs, though united by a common allegiance to the Crown and freely associated as members of the British Commonwealth of Nations." The conference of 1930 clarified certain legal points.

The Statute of Westminster specifically provided that legislation of dominion parliaments could not be objected to, even if repugnant to legislative acts of the British Parliament. Furthermore, no British legislation could apply in a dominion unless specifically requested. The act also repealed the Colonial Laws Validity Act, which had been passed in 1865 and which declared that colonial legislation, when in conflict with British legislation, was inferior to it. In reality, the act had not been enforced to any extent for years.

The Statute of Westminster, which has been advanced as the keystone of the arch of Canadian independence, granted little which had not been conceded earlier. In one particular the act was not all-inclusive: it did not stipulate that the parliament of Canada could amend the British North America Act, a British statute, which is the Canadian constitution.

J. J. T.

**STAUNTON** [sta′ntən], an independent city in northwestern Virginia, the county seat of Augusta Co., is situated in the Shenandoah Valley, 98 mi. northwest of Richmond, in a rich agricultural area, for which it is the trade center. The territory is renowned for its grain, apples, and livestock. Coal and building stone are natural resources of the region. Founded in 1736, Staunton was incorporated as a town in 1801 and as a city in 1870. The city's government is the council-manager type. In 1781 during the Revolutionary War the State General Assembly took refuge in Staunton, making it the state capital. During the Civil War, Union forces twice occupied the city. Staunton originated the city-manager, or council-manager, form of government in 1908. The city is the birthplace of Woodrow Wilson, whose home, which was built in 1846, has been restored as a shrine. A national and a Confederate cemetery are near by. The city is the seat of Mary Baldwin College. Transportation is afforded by the Chesapeake Western and the Chesapeake and Ohio railroads. Among the manufactures are men's clothing, furniture, and flour. Pop. 1950, 19,927.

**STAUROLITE** [stɔ′rolait], a mineral named from the Greek word meaning "cross," in allusion to its tendency to occur in cruciform twins. It is a ferrous iron aluminum silicate, $FeAl_5Si_2O_{12}(OH)$. Staurolite almost always occurs in single, flattened, elongate orthorhombic crystals. The color is brown when fresh, and the hardness is 7 to 7.5, but specimens are usually softer due to surface alteration to secondary mica. Staurolite is a typical mineral of regional metamorphism, occurring in staurolite schists. It is not a commercial mineral, except for rare gemworthy specimens and for well-developed twins which have sales value as religious emblems.

K. K. L.

**STAVANGER** [stɑ′vɑŋər], a seaport and fish-processing center, capital of Rogaland *fylke* (county) in southwestern Norway, 185 mi. southwest of Oslo. The city, the fourth largest in Norway, is located on a low rocky peninsula dotted with rounded hills, bordered on the west by the Atlantic Ocean and on the east by Stavanger Fjord, south branch of Bokn Fjord. Stavanger was founded in the eighth or ninth century and incorporated in 1425. Here in the eleventh century the English Bishop Reinald founded a cathedral dedicated to St. Swithin and completed in Gothic style in the twelfth and thirteenth centuries. The city lost its bishopric and much of its importance after the Lutheran Reformation in 1537; the bishopric was restored in 1924. In 1873 the first fish-preserving plant was built, to be followed by many others, which have brought about a commercial revival of the city. Large fish-packing plants and factories producing cans and boxes for this industry are located in Stavanger. During World War II it was the site of landings of the invading German armies in April 1940 and later was bombed by the British. Stavanger has advanced schools and a small museum. The city, connected with eastern Norway by the Jaeren Railway to Oslo, has rapid and frequent sea communications with Great Britain, the Continent, and North America. Southwest of Stavanger is the Sola Airport, started by the Norwegians before World War II and greatly expanded by the Germans during their occupation of Norway (1940-1945). It is considered one of the best-developed and located airports of western Europe and the strategic air center of the North. Pop. 1952, 50,888.

J. E. V.

**STAVESACRE** [ste′vzekər], an erect, downy, annual herb, *Delphinium staphisagria,* of the crowfoot family, native to southwestern Europe and Asia Minor. It grows as high as 4 ft. and has palmately divided leaves and terminal spikes of bluish flowers. The poisonous seeds, containing delphinine and other alkaloids, are used medicinally and in insecticides.

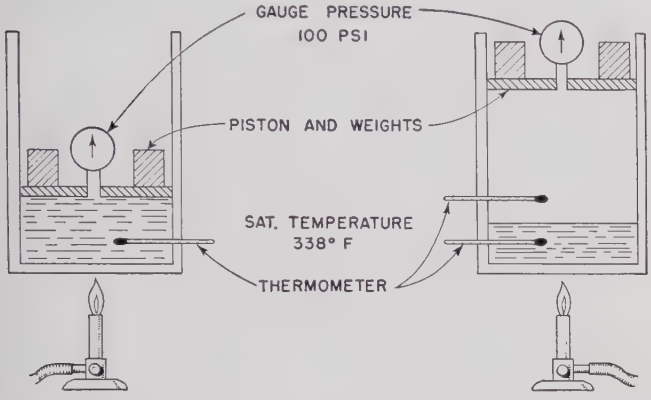
J. C. Wis.

**STEAM,** the gas or vapor form of water, chemically identical with liquid water. Contrary to the popular conception, it is invisible; the visible cloud issuing from a boiling kettle is a large number of very fine liquid drops of water carried along by the steam. The thermal properties of steam, which are defined here, make it an extremely important agent in maintaining life on the earth and in providing for the comfort and progress of man. It is well known, for instance, that heat from the sun is absorbed by the sea to form water vapor (steam) which rises into the atmosphere and is there condensed to form the clouds for rain and snow.

Evaporation, or vaporization, is the physical and thermal process that signifies the change of a liquid to a vapor, and condensation is a similar process in the reverse order.

To describe vaporization and the attendant physical and thermal properties, consider one pound of liquid water contained in a glass cylinder fitted with a piston, pressure gauge, and thermometer (*See* Fig. 1). The piston, which is free to move upward, is loaded with weights until the gauge reads a pressure of 100 lb. per square inch in excess of the atmosphere (gauge pressure); and the total pressure in the water is 115 lb. per square inch absolute. If heat is now applied, vaporization will begin at the saturation temperature, 338° F. (*See* table). With further heating, the saturated liquid water vaporizes to steam; the piston moves upward as shown in Fig. 2, and the temperature and the pressure remain unchanged. At this pressure, the heat of vaporization or amount of heat required to change one pound of water (from 338° F.) to one pound of saturated steam at 338° F. is 881 B.t.u. (*See* table). Again referring to the table, the one pound of water which occupied a liquid

volume of 0.0178 cu. ft. expanded 218 times to a steam volume of 3.88 cu. ft. If this experiment is repeated many times with increasing pressures, the expansion from liquid to vapor and the heat of vaporization will be observed to decrease to zero at the critical pressure, 3,206 lb. per square inch absolute. Also, the temperature required for vaporization will have increased to the critical temperature, 705° F.




*Figs. 1 & 2 (LEFT AND RIGHT, RESPECTIVELY)—THERMAL PROPERTIES OF STEAM*

In the first experiment, if the remaining liquid water were dispersed as small drops throughout the steam space before vaporization was complete, the steam would be called wet. Conversely, if all liquid water is converted to vapor, the steam is said to be dry. These conditions are represented by the quality, with dry steam indicated by 100 per cent. The quality cannot exceed 100 per cent, since further heating of dry steam will cause the temperature to rise above the saturation temperature, whereupon the steam is said to be superheated. The amount of this temperature rise is reported as the number of degrees of superheat.

PROPERTIES OF STEAM*

| Saturation Pressure | | *Saturation Temperature, °F.* | Specific Volume, Cu. Ft. per Lb. | | *Heat of Vaporization, B.t.u. per lb.* |
|---|---|---|---|---|---|
| *Gauge* | *Absolute* | | *Liquid* | *Vapor* | |
| In. of Mercury Vacuum | In. of Mercury | | | | |
| 29 | 1 | 79 | 0.0161 | 652.0 | 1,049 |
| 20 | 10 | 161 | 0.0164 | 74.8 | 1,001 |
| 10 | 20 | 192 | 0.0166 | 39.1 | 983 |
| Lb. per Sq. In. | Lb. per Sq. In. Absolute | | | | |
| 0 | 14.70† | 212 | 0.0167 | 26.8 | 970 |
| 50 | 65 | 298 | 0.0174 | 6.66 | 912 |
| 100 | 115 | 338 | 0.0178 | 3.88 | 881 |
| 500 | 515 | 467 | 0.0197 | 0.901 | 751 |
| 1,000 | 1,015 | 545 | 0.0216 | 0.438 | 649 |
| 2,000 | 2,015 | 636 | 0.0257 | 0.186 | 460 |
| 3,192 | 3,206 | 705 | 0.0503 | 0.0503 | 0 |

*Data obtained from J. H. Keenan and F. G. Keyes, *Thermodynamic Properties of Steam*, 1st. ed., 1936, New York.

†Standard atmospheric pressure, 14.696 lb. per square inch absolute, and 29.992 in. of mercury, or approximately 15 and 30, respectively.

## SUPERHEATER

A superheater is a vapor-heating apparatus, most commonly used to increase the temperature of steam above its normal boiling point. A high-temperature superheated steam is required for economy in the performance of steam engines and turbines, the steam consumption being reduced about 1 per cent for each 10° F. of superheat. The upper limit of temperature is determined by the heat-resistance properties of the machines and materials rather than the advantages of improved performance. In the period from 1905 to 1950 the highest superheat steam temperature was increased from 550 to 1,050° F., 950° F. being widely used in large power plants after 1938.

The apparatus is constructed of steel tubing forming a heating surface for the steam that flows within it. Saturated steam from the boiler enters the tubing at one end and is heated to the desired outlet temperature by heat applied to the outside surface. Compared with the boiler heating surface, the superheater tubing surface area will vary from about one-half, for moderate temperatures, to twice that of the boiler for high steam temperature.

**Types.** Although the superheater may be of the separately fired type, that is, an independent furnace containing the superheater only and connected to a boiler, the large majority are built into the steam generator. These integral superheaters are of two general classes: radiant and convection. Other names, such as interpass, interdeck, overdeck, intertube, and interbank, are used to describe the position of the superheater with respect to the principal boiler heating surface. One square foot of the surface of the radiant-type superheater, which is located to receive radiant heat from the combustion zone of the steam-generator furnace, will transfer from two to three times as much heat as that for the convection type. The convection superheater, located in the higher-temperature regions of the boiler gas passages, depends upon convection heat or the heat obtained from the flow of hot gases passing over the tube surface.

**Controls.** Since the steam pressure is usually the maximum permissible, superheater controls are provided to maintain the desired temperature (within —10° F.) for the operating range of steaming rates of a particular steam generator. It is characteristic of superheater performance that the steam temperature from the radiant type will decrease as the steaming rate or load increases, whereas that for the convection type increases. This behavior is used in one method of control, in which both types installed in series form a combined superheater that limits the amount of temperature variation. A gas by-pass or damper-controlled system is most often used. It diverts a fraction of the hot gases around a convection-type superheater to lower the steam temperature. Other methods include the differential control of firing rates where permitted, as with multiple burners in the furnace; twin furnaces or separately fired superheaters; and the attemperator or desuperheater control, in which the superheated steam is cooled by contact or liquid water spray.

## STEAM GENERATOR

A steam generator includes equipment or apparatus for producing water vapor, or steam, from liquid water. Thus, the boiler is a steam generator. However, the term usually denotes a boiler with one or all of the following associated equipment: superheater, economizer, air preheater, steam reheater, and such auxiliaries as are necessary for satisfactory operation of the unit. Generation of the steam required to produce power is a major industry, considering that the use of steam is predominant for railroad and marine power plants, and represents about two-thirds of the electrical energy produced by utility and industrial plants of the United States. Development of the steam generator since the middle 1920's

has resulted in increased steam capacity, pressure, temperature, and economy, as a result of improved materials and methods and the effective use of heat-recovery apparatus. Sustained commercial operation has been obtained with single units at over 800,000 lb. of steam an hour, 1,250 lb. per square inch pressure, 950° F. temperature, and an average 85 per cent over-all efficiency.

The steam generator is designed or modified to meet the economic requirements of every installation. This is particularly true for the largest central station power plants for which steam generators are built to order. Some of the more important factors that must be considered are the type of fuel, whether solid, liquid, or gas; the firing methods and physical characteristics, particularly of solid fuels; steam pressure and temperature; suitability of feed water; maximum continuous and peak steaming capacities; available space for installation; monetary value of increased efficiency; and required reliability of operation. H. A. J.

## STEAM ACCUMULATOR

A steam accumulator is an apparatus for storing heat energy in steam when supply exceeds demand, rendering it available for later use. It is, in effect, a steam flywheel, It is connected between two steam systems, one at higher pressure than the other, to store up heat from the higher pressure system and deliver it to the lower pressure system to supply peak loads. This arrangement permits the higher-pressure system to operate at constant pressure and load, a condition that is always best for boilers.

**Capacity.** Most accumulators are insulated steel tanks, welded or riveted, from 6 or 7 ft. to 15 or 16 ft. in diameter and from 15 to 60 ft. in length, with water capacity from 200 to 15,000 cu. ft. They are usually about nine-tenths full of water. The capacity in steam storage depends on the supply and discharge pressures and temperatures, which determine the heat drop. In one installation, a 16 by 55-ft. accumulator had a storage capacity of 45,000 lb. of steam between 90 and 15 lb. per sq. in. pressure.

**Theory.** Steam from boiler or boilers at high pressure is fed into the water, which condenses the steam by direct contact and absorbs heat from it. Then, if there is a demand for steam at the lower pressure, the pressure in the accumulator is lowered and the heat already absorbed in the water will cause 20 to 40 per cent of the water to evaporate into steam at the lower pressure. This steam is withdrawn to meet the low-pressure peak demand. This process lowers the temperature of the water in the tank, which can then condense more high-pressure steam. Automatic control valves on the steam-admission and steam-withdrawing pipe lines adjust the flows of steam, to proportion the required steam flows from boiler and accumulator to the steam-using equipment.

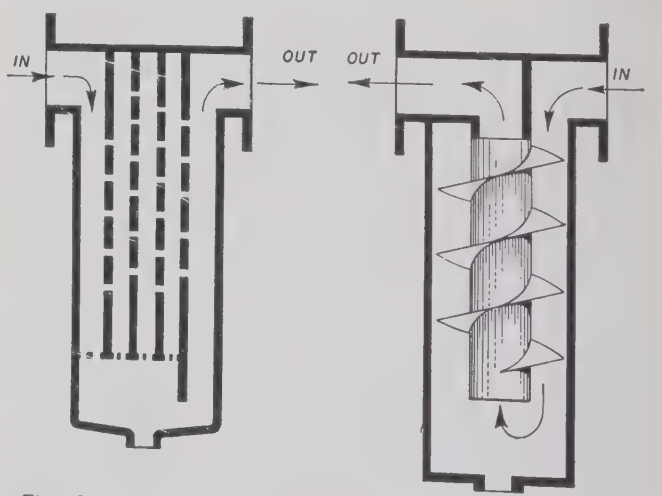
For example, if the pressure in a tank of water or in a steam boiler is 415 lb. per sq. in. and the pressure is decreased to 325 lb. per sq. in., then 1.7 lb. of steam will be released from each cubic foot of the water. If the original pressure were 150 lb. per sq. in. and if it were decreased to 75 lb. per sq. in., each cubic foot of water would produce 3.7 lb. of steam. The amount of steam released per cubic foot of water depends on the average density of the water in pounds per cubic foot (the density varies with pressure and temperature) and also on the difference in heat between the upper and lower pressure and temperature limits.

**Applications.** From 1918 to 1928, the steam accumulator was developed and applied extensively in Europe by the Ruths Accumulator Company, Inc. In 1928 there were 317 installations by that company in Europe and 16 in the United States. The accumulator principle, however, had been used earlier in Europe by C. H. Smoot. Rateau accumulators were also installed in the United States, principally in connection with gas works. By 1928, the Kiesselbach constant-pressure accumulator had also been developed. In this apparatus, heat in steam is stored in water, but hot water is delivered by the accumulator instead of steam, the pressure in the accumulator always remaining essentially constant.

Engineers in the United States have not applied the steam accumulator extensively. When it was first developed, boilers and firing equipment were relatively inflexible in serving fluctuating loads and could attain maximum efficiency only at a very short, high range of output. Since about 1930, however, boilers and firing equipment have been developed that can maintain satisfactory fuel economy over the ranges of steam demand which occur in most industrial processes. Pulverized-coal firing, new types of stokers, and wide-range oil and gas burners have made this improvement possible. Automatic combustion controls, which have also been brought to a high degree of perfection, help to maintain good fuel economy over wide ranges of boiler output. For these reasons and many others, the need originally met by the steam accumulator is now generally met by the boiler itself; or, in exceptional cases, the boiler may be especially designed to supply its own accumulator effect.

## STEAM SEPARATOR

A steam separator is a device for removing droplets of water from steam flowing in a pipe, so that steam alone will reach the consuming apparatus. The droplets of water may be in the steam when it enters the pipe but, even if the steam is dry, some condensation will occur. This is because it gives up some of its heat to warm the pipe; and, at the same time, even if the pipe is insulated, a small but appreciable heat loss will occur through the insulation, since it is uneconomical to attempt perfect insulation.




*Figs. 3 & 4* (LEFT AND RIGHT, RESPECTIVELY)—FORMS OF STEAM SEPARATORS.

Fig. 3: *Baffle type;* Fig. 4: *Centrifugal type*

The water of condensation, termed condensate, formed by the water droplets carried in the steam, prevents the steam from transmitting its heat most efficiently in the steam-consuming apparatus. Also, if in some way water were to accumulate in a pocket in the steam line and be forced along

at high velocity, it would form a water hammer, striking valves, pipe fittings, and other equipment with sufficient force to break them.

To dry the steam, it is customary to use separators just ahead of the steam-consuming apparatus. These remove the droplets, or masses of water, and allow the dried steam to pass on. One form of separator, as in Fig. 3, gives a sudden change in direction to the steam. The heavier particles of water try to go straight ahead, but strike the baffles and flow down to a sump at the bottom of the separator. Another form of separator (Fig. 4) imparts a whirling motion to the steam, and throws the moisture particles away from the steam flow, so that they collect on the separator sides and fall to a sump or collection chamber at the bottom. In both instances, the water space at the separator bottom is drained through a steam trap, which allows the water to flow out, but not steam.

In one form of separator, the baffles shown in Fig. 3 are replaced by a fine-mesh screen. Other types use a porous stone to absorb the moisture in the steam, letting it drip into the sump, while still another type directs the steam flow through a felt pad which absorbs the moisture. Gridiron plates are also used in some instances to collect the moisture. The most commonly used types, however, are those which utilize a change of direction, plus baffles of some kind, or those which employ whirling action, or a combination of the two.

## STEAM TRAPS

Steam traps are automatic valves used to allow draining of condensate, and sometimes air, from closed steam spaces at the rate at which the condensate forms. Condensate is the water formed when steam in a closed space gives up heat to some other substance surrounding, or enclosed in, the steam space—as in an ordinary steam radiator, a heating coil, or a jacket on a process kettle. Condensate must be properly drained as formed, so that the steam can continue to flow fast enough to supply the required amount of heat. The steam trap is only a controller; it does not drain condensate, but merely recognizes the arrival of steam or condensate. It closes to prevent waste of steam, and opens to allow the steam pressure to push the condensate through for further disposal. Traps are of these fundamental types: mechanically operated (bucket or float); thermostatically operated; labyrinth or orifice type.

The mechanically operated trap depends for operation on filling of a bucket with condensate, as in the open-top bucket trap, to furnish power for opening the valve; or on the buoyancy of a float. Some depend on the difference in weight between condensate and steam, as in tilting traps, in which the condensate accumulation tilts the trap body around a pivot and opens the valve. Some float trap mechanisms are relays, operating a separate steam valve to admit steam and force out the condensate.

Thermostatic traps operate on the principle that a tube, or bellows, when in contact with condensate, holds the valve open and the steam forces the condensate out through the valve. However, as hot condensate and steam reach the tube or bellows, it expands, closing the valve. In one type, an expanding liquid in a jacket outside the tube provides the force for closing the valve.

The labyrinth type employs several expansion chambers or orifices, through which steam expands with increase in volume, closing the valve, whereas condensate flows through at constant volume. In the impulse trap, two orifices, a chamber between, and a small passage through the valve, are all proportioned so that, as condensate increases, pressure builds up under the valve, which lifts and discharges condensate, but closes when steam arrives.

Several types of pumping traps, lift traps, and boiler feed return traps employ various combinations of the above fundamental principles. C. R. E.

## STEAM CALORIMETER

A steam calorimeter is a device used for the determination of the quality of wet steam. Wet steam is a mechanical mixture of small drops of liquid water and gaseous water vapor. The proportion of gaseous water vapor in the mixture may vary and is expressed in terms of quality, the extreme limits being 0 per cent quality (all liquid) and 100 per cent quality (all gaseous). Between these limits, and at a given pressure, the temperature is the same for all qualities, so that simultaneous measurements of pressure and temperature, alone, are not sufficient to determine either the quality of the steam or the values of other properties such as specific volume, entropy, or enthalpy. The steam calorimeter, however, furnishes a means of determining the quality of a mixture and, from this, the values of all other properties. It is, therefore, a most important instrument in the testing of engines or other equipment using nonsuperheated steam.

**Operation.** All calorimeters require that steam be drawn from the test source at a low constant rate, usually of the order of 75 lb. per hr. This sample is then subjected to either a drying or superheating process, and then discarded at a pressure slightly above atmospheric. Separating calorimeters dry the steam sample, while throttling and electric calorimeters cause the steam sample at discharge to be slightly superheated.

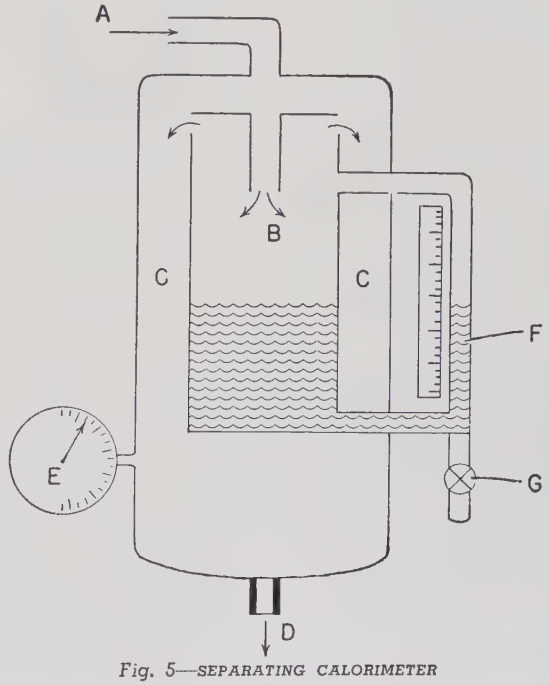



*Fig. 5—SEPARATING CALORIMETER*

*Separating Calorimeter.* Fig. 5 shows a cross section of a separating calorimeter. Steam entering at *A* flows into chamber *B* at high velocity. The inertia of the dense liquid droplets causes them to impinge on the sides of the chamber and to collect in a little pool, as shown. The much less dense vapor, however, reverses its direction and passes through an annular space around the inlet nozzle, and then into the jacket space *C*. The dried steam sample then escapes to the atmosphere through the calibrated outlet orifice *D*.

The quality of the steam entering chamber $B$ may be calculated from the expression:

$$x = \frac{W}{w + W} = \textit{Quality (in per cent)},$$

where $W$ equals the rate of flow of dry steam through nozzle $D$, and $w$ equals the rate at which liquid water collects in chamber $B$. Nozzle $D$ is calibrated in terms of readings of pressure gauge $E$. The water level glass $F$ is fitted with a scale calibrated in pounds and has a drain $G$. The entire exterior of the device is highly polished to minimize heat loss by radiation. Orifices of various sizes may be used for the discharge $D$, the size being selected so that the rate of flow $W$ is sufficiently large to make unnecessary the correction of $W$ for radiation losses. The rate of accumulation $w$ of water in chamber $B$ is determined by timing of the level change, while the rate of steam discharge, $W$, is computed from the pressure gauge reading and from the calibration equation for the discharge orifice.

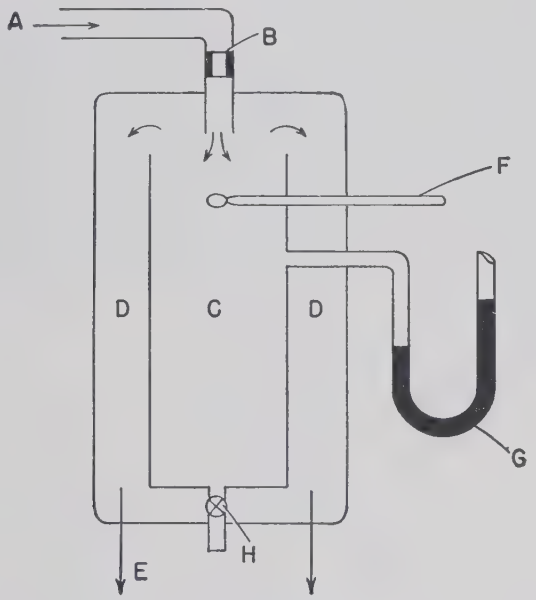



*Fig. 6—THROTTLING CALORIMETER*

*Throttling Calorimeter.* Fig. 6 shows the cross section of a throttling calorimeter. Steam enters the device at $A$ and passes through orifice $B$ into chamber $C$, and then through jacket $D$ to atmospheric discharge $E$. The enthalpy of the steam at $C$ is the same as that at $A$, but the pressure at $C$ is practically atmospheric. If the quality of the steam at $A$ is not too low, the steam at $C$ will be superheated, in which case simultaneous measurements of pressure and temperature in chamber $C$ will determine the thermodynamic state of the steam there. The quality of the steam at $A$ is determined by equating the enthalpy at $A$ to that at $C$. The enthalpy at $C$ can be evaluated directly since the amount of superheat has been measured. The exterior surface of this type of calorimeter is plated and polished to minimize the rate of heat loss by radiation. Also, the orifice $B$ is replaceable in various sizes. The size of orifice selected should be such as to insure a flow rate sufficiently high to keep heat losses from the jacket negligibly small as compared to the total enthalpy of all steam flowing through chamber $C$. Other parts of this calorimeter are: thermometer $F$, pressure manometer $G$, and drain valve $H$.

*Electric Calorimeter.* The electric superheating calorimeter resembles the other types in outward appearance. Inside, this type includes an electrically-heated channel. In operation, steam enters the heating section from an orifice so that the pressure in the heating section is atmospheric. The heating units are supplied with power sufficient to cause the steam to be superheated at the outlet. Measurements required include the temperature and pressure of the steam at outlet, the power used by the resistance, and the pressure of the steam before the metering orifice. The calculation for obtaining the initial enthalpy of the steam is based on a heat balance in which the heat added electrically is equated to the change in enthalpy required for drying and superheating the steam to its final condition.

**Use.** The throttling calorimeter is the most widely used device for evaluating quality. This is logical since it is the simplest of the three to operate and also because its narrow range of utility (qualities of 96 to 100 per cent) coincides with the range of steam qualities normally encountered.

*Error in Use.* The source of most error in the determination of steam quality is in the quality of the steam sample entering the calorimeter not representing the average quality of all the steam passing the sampling point. If the direction of flow of the steam is horizontal at the sampling point, the water droplets may fall to the bottom of the pipe, and if the direction of steam flow is vertically downward, the water droplets may cling to the walls and flow downward in small streams. Therefore, it is standard practice to locate the sampling point in a comparatively long vertical pipe in which the steam is flowing upwards. A standard sampling tube is also used in an effort to make certain that the steam sample represents the average quality to be found along any radius of the pipe at the sampling point. Specifications for sampling tubes may be found in the test codes which apply.

E. D. H.

## STEAM ENGINES

Steam engines are reciprocating piston prime movers which convert the heat and pressure energies of steam into mechanical work. Externally generated steam is piped to the engine valve chest (steam chest). The valve admits a charge of steam to a cylinder at the proper position of a piston. The pressure of the steam on the piston forces the piston to move and to produce mechanical work thereby.

**History.** The modern steam engine, in its multiplicity of forms, is an aggregate of inventions. The ancients recognized the potential energy of water when turned into steam by the application of heat. The first record of an approach to the useful employment of this energy appears in *Pneumatica,* by Heron of Alexandria, who lived about the second century, B.C. Heron sketched and described devices such as "a fountain which is made to flow by the action of the sun's rays." In his contrivance, a spherical vessel was mounted over a closed tank, with a pipe from the bottom of the tank to the top of the sphere. A second pipe, in the form of a siphon, led from the bottom of the sphere to a basin. The tank and sphere were partially filled with water. The sun's rays heated the water in the sphere to form steam, which forced water from the sphere through the siphon to the basin. At night the sphere cooled, the steam condensed, and water was drawn up into the sphere from the tank by the partial vacuum so produced. No mention was made of the necessary valve in the siphon pipe for such a filling action to occur. This device was the forerunner of the steam pump and steam engine.

Not until the sixteenth century do writings appear that further hint at the knowledge of the properties of steam and of the advantages of its application to perform work. Jacob

Besson, in 1569, and Agostino Ramelli, in 1588, wrote of the properties of steam, and of machines and mechanisms designed to utilize those properties. Leonardo da Vinci described a steam gun, in which the steam was generated in the gun chamber by permitting water to fall on a heated surface. The sudden expansion of the water into steam would serve to eject a ball from the chamber.

*Early Engines.* In 1601, Giovanni Battista della Porta described a water-raising device that made use of the pressure of steam to cause a water outflow from a chamber, and also of the vacuum created by condensation of the steam to cause an inflow of water. Della Porta is also credited with the first separation of the forcing vessel, or engine, from the steam generator, or boiler. About 1628, Edward Somerset, Marquis of Worcester, invented the first large-scale application of the steam engine. His machine was designed to raise water. In operation, it was essentially the same as Della Porta's engine with an external steam boiler, suitable piping, and valves.

At the end of the seventeenth century, English mines had become so deep that their drainage became a major problem. The development of the steam engine was given added impetus by this need. Thomas Savery, in 1698, patented the first engine that was actually employed for this work. To some extent, it was also used to supply towns with water, so that Savery is credited with the first machine to use the power of heat for general utility. His engine was similar in principle to Somerset's. It was modified by others to improve its performance, but its large size and operational difficulties prevented its widespread application. Up to this time, the engines used the steam directly in the water. Christian Huyghens, in 1680, had proposed a gunpowder engine using a piston. Denys Papin, in 1690, used the piston in a steam engine but did not perfect the invention as a continuous source of power.

Thomas Newcomen, in 1705, patented a steam engine consisting of a steam cylinder containing a piston similar to that of Papin's, and driving a separate pump (*See* Fig. 7).

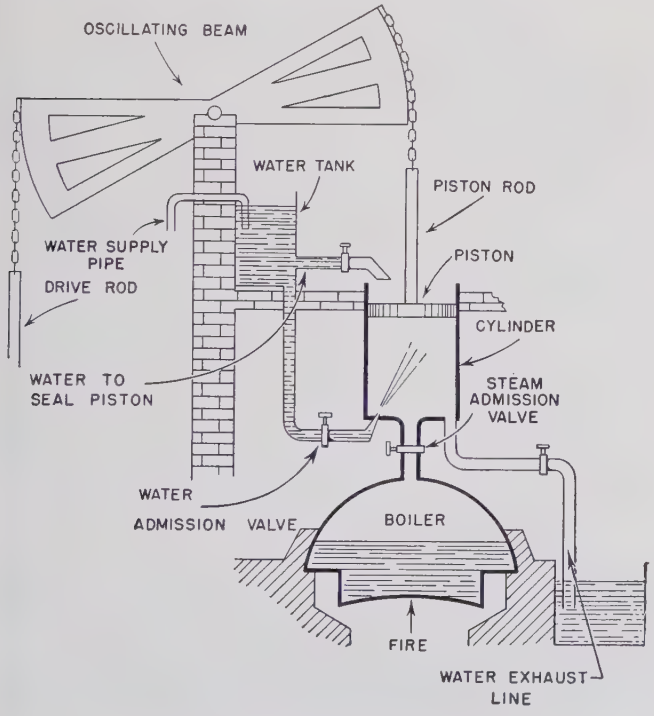



*Fig. 7—THE NEWCOMEN STEAM ENGINE*

Steam was admitted to a cylinder to raise the piston. A jet of water was then sprayed into the cylinder to condense the steam and to create a vacuum. Atmospheric pressure then forced the piston downward. The piston motion was transferred to a separate pump by an oscillating beam. This engine, with modifications of the mechanism, was adopted extensively in all British mining districts and was also used in mills and water-supply systems.

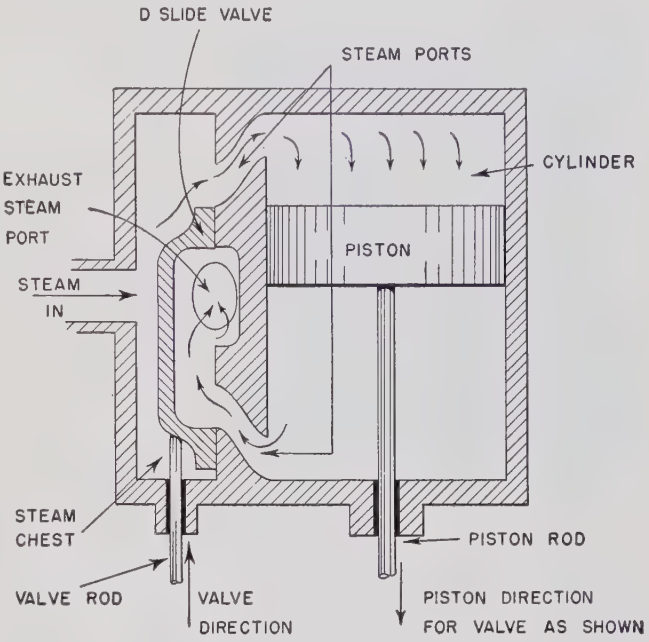



*Fig. 8—BASIC PRINCIPLES OF THE MODERN, D-VALVE, DOUBLE-ACTING STEAM ENGINE*

*Watt's Contributions.* James Watt applied scientific reasoning and experimentation to the engines of Newcomen to develop means to increase their effectiveness and efficiency. The introduction of water into the cylinder of the Newcomen engine cooled the cylinder and walls to such an extent that some of the energy of the next charge of steam was used to reheat the walls without performing useful work. Watt, in 1764, devised the external condenser, together with other improvements. A decade later, he produced the first engine of the modern type. His achievements also included the double-acting steam cylinder, in which steam acted alternately on both sides of the piston; the noncondensing engine, which used no condenser but exhausted the steam to the atmosphere; and the double-cylinder or compound engine, in which steam was admitted to one cylinder. In this cylinder, only part of the energy of the steam was used. The steam was then passed to the other cylinder for further utilization of the energy.

Developments from the time of Watt have been in refinements of the Watt engine. The basic principles (*See* Fig. 8) and mechanisms have not changed.

## CLASSIFICATION

Steam engines are designated according to speed, cycle, mechanical features such as valves and cylinder arrangement, use, and power rating.

**By Speed.** Because of the large masses of the reciprocating parts, the speeds of the engines are limited. High-speed engines operate in the range of from 300 to 500 revolutions per minute, moderate-speed from 100 to 200 r.p.m., and slow-speed from 60 to 90 r.p.m.

**By Steam Cycle.** The energy of the steam may be utilized in the cylinder in one of two basic cycles. Nonexpansion engines (*See* Fig. 9) admit steam at line pressure to the cylinder at the top of the piston stroke. The full steam pressure is maintained on the piston to the bottom of the stroke. Such engines are relatively inefficient, since the energy of expansion of the steam is not used. The work output per piston stroke is a maximum in this cycle. Small engines for intermittent operation, where economy is not important, use this cycle.

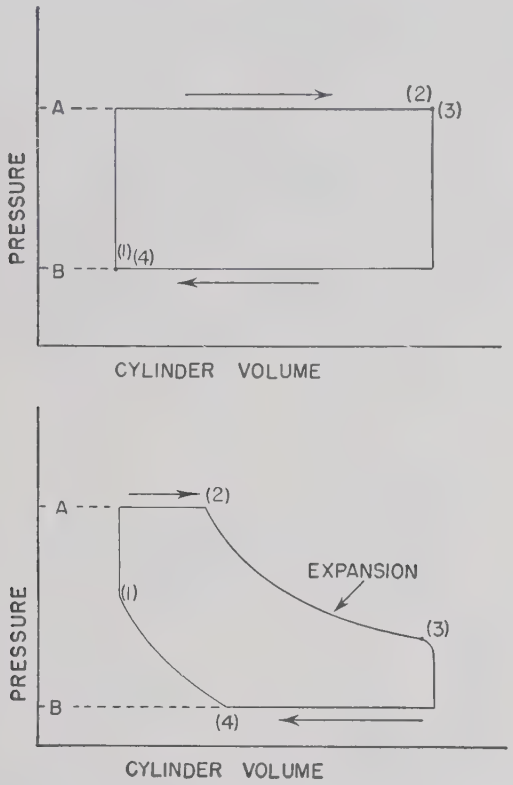



*Fig. 9—STEAM CYCLE DIAGRAMS: (TOP) NON-EXPANSION ENGINE CYCLE; (BOTTOM) EXPANSION ENGINE CYCLE*

*(A) Steam pressure; (B) Exhaust pressure; (1) Inlet valve opens; (2) Inlet valve closes (cutoff); (3) Exhaust valve opens (release); (4) Exhaust valve closes. (Arrows indicate direction of piston movement.)*

The expansion engine (*See* Fig. 9) is used for greater economy or efficiency. The steam supply to the cylinder is cut off when the piston has traveled approximately one-fourth to one-third of its stroke. The trapped steam then expands in the cylinder, and this energy is utilized to drive the piston the remainder of the stroke. The steam is usually released at a pressure somewhat higher than the discharge pressure. This method reduces excessive cooling of the cylinder walls due to the drop in temperature on expansion and also reduces the over-all size of the engine.

In condensing engines the steam is exhausted to an external condenser to condense the steam for final removal from the circuit in the form of water. With this feature the exhaust pressure may be less than atmospheric to effect a gain in the expansion energy release. Noncondensing engines exhaust directly to the atmosphere.

**By Valves.** The steam-engine valve controls the admission and rejection of steam to the cylinder. In the slide-valve engine both operations are performed by the same valve. The D valve, or piston valve, actuated from an eccentric on the engine crank, oscillates in the steam chest to uncover ports in the cylinder walls. The same ports are used for admission or exhaust of the steam. The colder exhaust steam cools the region around the ports and the hot entering steam reheats the wall with a consequent loss of energy of the steam.

In 1908, Johann Strumpf invented and patented the uniflow engine (*See* Fig. 10). A single steam valve in the cylinder head admits steam to the cylinder. Exhaust takes place at ports in the middle of the cylinder when the piston uncovers these ports. The thermal performance of the engine is better than that of the slide-valve type, since the working parts are kept at essentially the same temperature and initial condensation is reduced.

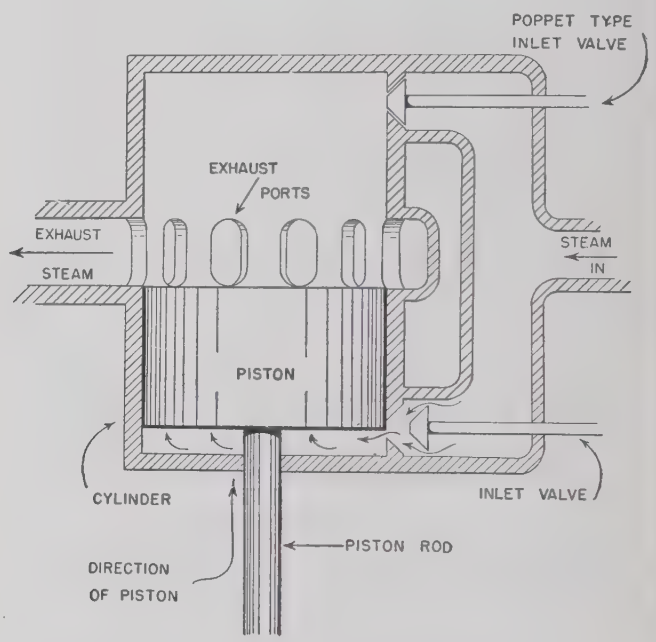



*Fig. 10—DOUBLE-ACTING UNIFLOW ENGINE*

**By Cylinder Arrangement.** To reduce the temperature difference between the inlet and exhaust steam in any one cylinder and to reduce the single-cylinder size, compound or multiple-expansion engines are used. Steam enters one cylinder, where some of the energy is removed; the steam then passes to a second cylinder, in which the steam is further expanded. All cylinders drive a common crank. Quadruple-expansion engines (four cylinders) have been built.

**By Use.** Stationary engines are used to drive generators, pumps, or other mechanisms. Steam engines for stationary applications of over 500 horsepower have been largely superseded by the steam turbine with its higher rotation speeds, smaller size, and greater efficiency.

The steam-line throttle-valve opening may be positioned by hand for variable-speed steam-engine operation. The engine may also be reversed by suitable mechanisms on the valve linkage. These features are necessary for locomotive and ship operation.

A quadruple-expansion marine steam engine of 20,000 hp. was built in 1900. Until 1920 the steam engine was the most common type of prime mover in marine service. Since then, the steam turbine and diesel engine have largely displaced the steam engine in marine applications. However, during World War II, triple-expansion steam engines of 2,500 hp. were installed in the emergency Liberty ships. *See also* EN-

GINES, INTERNAL COMBUSTION; HEAT AND THERMODYNAMICS; POWER PLANTS. H. W. I.

**STEAMBOAT.** *See* VESSELS, INLAND WATERWAY.
**STEAM CONDENSER.** *See* CONDENSER, STEAM.
**STEAM POWER PLANTS.** *See* POWER PLANTS.
**STEAMSHIP.** *See* SHIPS, MERCHANT.
**STEAM SHOVEL.** *See* EXCAVATORS.
**STEATITE.** *See* TALC.

**STEATOPYGIA** [sti'ətopai'jiə], an anatomical characteristic found in its most extreme form as a racial trait of the Bushman-Hottentot. It consists of an excessive accumulation of fat localized largely in the buttocks, making them distinctly protuberant. Prehistoric figurines found in Europe displaying this peculiarity have suggested to some scholars the possibility that the Bushman stock once inhabited southern Europe. H. L. Sh.

**STEDMAN, EDMUND CLARENCE** (1833-1908), American poet, critic, and essayist, was born Oct. 8, 1833, in Hartford, Conn. Expelled from Yale in 1852, he became a journalist and was war correspondent for the *New York World* in 1861. From 1869 to 1900 Stedman was a member of the New York Stock Exchange, doing literary work in his spare time. Representative of his verse are his first volume, *Poems Lyrical and Idyllic* (1860), *Alice of Monmouth* (1864), and *The Blameless Prince* (1869), which contained his best-known poem, *Pan in Wall Street.* His chief anthologies are *An American Anthology* (1900); and *A Library of American Literature,* which appeared in 11 volumes between 1887 and 1890, and which he edited with Ellen M. Hutchinson. His leading critical works are *The Victorian Poets* (1875); *The Poets of America* (1885); and *The Nature and Elements of Poetry* (1892). He was the foremost American critic in an age that admired the genteel tradition. He died in New York on Jan. 18, 1908. A. La.

**STEEL.** *See* ENGINEERING MATERIALS; IRON AND STEEL.

**STEELE, SIR RICHARD** (1672-1729), British essayist and playwright, was born probably on March 12, 1672, in Dublin, Ireland. Steele began his schooling in 1684 at Charterhouse, where he met Joseph Addison, whom he followed to Oxford in 1689. Not waiting for a degree, Steele entered the army in 1694, rose to a captaincy by 1700, and left the army about 1705.

Steele's literary career began with the publication of *The Christian Hero* (1701), written to prove "that no principles but those of religion are sufficient to make a great man." Turning to drama, he wrote *The Funeral, or Grief à-la-Mode* (1701), *The Lying Lover, or the Ladies' Friendship* (1703), and *The Tender Husband; or, the Accomplished Fools* (1705). Having become co-manager of the theatre in Drury Lane in 1714, he produced his best example of the sentimental comedy, *The Conscious Lovers,* in 1722. Though Colley Cibber's *Love's Last Shift* (1696) pioneered in sentimental comedy, Steele, in his efforts "to chasten wit, and moralize the stage," distinctly contributed to the reformation of manners by painting vice in its true colors and depicting virtuous characters worthy of emulation.

In a sense anticipated by John Dunton and Daniel Defoe, Steele, appointed Gazetteer (1707), entered the field of the periodical essay with *The Tatler* (1709-1711), under the editorial pseudonym of Isaac Bickerstaff, Esq., and was joined by Addison in the eighteenth number of the tri-weekly publication. *The Tatler* was followed by *The Spectator* (1711-1712), published six days weekly, and *The Guardian* (1713). Later periodicals started by Steele never achieved the success of his first two ventures. In the periodical essays, Steele and Addison preached the genial gospel of good sense, good taste, and good manners to a cultivated few and to a middle-class group of readers who frequented the coffee houses in London and were rapidly gaining economic and political significance. Steele, not so learned as his friend Addison,

*SIR RICHARD STEELE*

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with whom he later quarreled, was a man of varied tastes and broad sympathies. He attacked duelling, cruelty to animals, and the stupidity and cruelty of schoolmasters; he preached child welfare and praised domestic felicity; he argued for female education and delineated superbly the characters of the Spectator's Club. His essays on virtue in distress were suggestive to the sentimental novelists who followed him. Mention should also be made of his love letters to his wife, "Dear Prue," which are among the finest in English. Predeceased by his wife, Steele died at Carmarthen, Wales, on Sept. 1, 1729. H. Dr.

**STEELE, WILBUR DANIEL** (1886- ), American author, was born in Greensboro, N. C., Mar. 17, 1886. He was educated at the University of Denver, where his father was professor of Biblical literature, and after his graduation in 1907, studied art at the Museum of Fine Arts in Boston, Mass. From 1908 to 1909 he attended the Académie Julian in Paris, and in the following year he studied at the Art Students League in New York. Settling in Provincetown, Mass., in 1910, he gradually abandoned his career as a painter to pursue his interest in writing, and his first success in this field was with the publication of the story *A White Horse Winner* in the *Atlantic Monthly* in 1912. During World War I he was a naval correspondent. He has traveled and lived in the West Indies, Bermuda, North Africa, France, and England.

His first novel, *Storm,* was published in 1914 and was followed by six other full-length novels: *Isles of the Blest* (1924), *Taboo* (1925), *Meat* (1928), *Sound of Rowlocks* (1938), *That Girl from Memphis* (1945), and *Diamond Wedding* (1950). He has also written some one-act plays, collected in *The Terrible Woman* (1925). In collaboration with his wife, Norma Mitchell, he wrote the full-length plays *Post Road* (1934), which had a successful run on the New York stage, and *Penny* (1937); and with Anthony Brown he wrote the play *How Beautiful with Shoes* (1935), adapted from his story of the same name. Steele is, how-

ever, best known as a short-story writer. He has been five times a winner of the O. Henry Memorial prizes: in 1919 he was awarded second prize for the story *For They Know Not What They Do;* in 1921 he received a special award for maintaining the highest level of merit for three years among American short-story writers; in 1925 he tied with Julian Street for first honors with the story *The Man Who Saw Through Heaven;* and in 1926 and 1931 he again took first prize with the stories *Bubbles* and *Can't Cross Jordan by Myself.* In addition he won the fourth *Harpers Magazine* short-story contest with his story *When Hell Froze.* His short stories have been collected in *Land's End* (1918), *The Shame Dance* (1923), *Urkey Island* (1926), *The Man Who Saw Through Heaven* (1927), *Tower of Sand* (1929), and *The Best Stories of Wilbur Daniel Steele* (1946). His stories, usually laid in New England or South Carolina, reveal a bent for the horrifying and the terrible, pursued with rare ingenuity and distinction. C. W. D.

**STEELHEAD.** *See* Rainbow Trout or Steelhead.

**STEELTON,** a borough in Dauphin Co., in south central Pennsylvania, situated on the Susquehanna River, 3 mi. southeast of Harrisburg. Freight facilities are provided by the Steelton & Highspire, the Pennsylvania, and the Reading railroads. Steel and cigars are the chief manufactures. Steelton, formerly known as Baldwin, was incorporated in 1880. Pop. 1950, 12,574.

**STEEN, JAN HAVIKSZ** [ste'n] (1626-1679), Dutch genre painter, was born at Leyden in 1626. He studied at Utrecht under Nicolas Knupfer, at The Hague under Jan van Goyen, and at Haarlem under Adriaen van Ostade. He entered the painters' guild in Leyden in 1648. He is known to have managed a brewery in Delft from 1654 to 1660; he lived in Haarlem between 1661 and 1669; and he ran a tavern in Leyden from 1669 until his death. Steen revealed in his paintings a superb sense of humor and an awareness of the anecdotal and whimsical in human relations. Focused upon lower middle-class family life, most of the five hundred odd paintings ascribed to him present scenes of common occurrence in the family living-room, the kitchen, or the town tavern. Occasional biblical, mythological and historical subjects he almost invariably interpreted as local, current events. His deft compositional arrangement and coloration did not consistently match his descriptive ability, but at its best his tonal scheme is excellent, usually featuring warm yellow and red costumes contrasted with blue and enlivened with touches of reflected highlights. He died at Leyden, Feb. 3, 1679. R. A. K.

**STEEPLECHASING,** the racing of horses over a course beset with fences, walls, brooks, hedges, and other obstacles that a horseman might encounter riding cross-country. The sport originated in Ireland in the eighteenth century and is an outgrowth of foxhunting. During the course of a season's pursuit of the fox across the banks, walls, and ditches of the Emerald Isle, it was quite natural that the bolder horsemen should drift into arguments about the speeds of their respective mounts. These arguments frequently evolved into challenges and match races across country to a prominent landmark, usually a church steeple.

**Steeplechasing Abroad.** The first steeplechase of which an authentic record survives was run in 1752. Another account tells of a race run in 1792 which appears to be the first steeplechase in which more than two riders competed. The first organized steeplechase, however, was not run until 1830, and its success did much to establish the popularity of this form of horse racing.

The Grand National, which for more than a hundred years has been the most famous of all steeplechases, was first run at Aintree, near Liverpool, on Feb. 29, 1836. In 1839, sponsorship of the race was taken over by a company headed by the Earl of Derby, Lord Sefton, and others, and the first race run under these auspices, known as the Grand Liverpool Steeplechase, was run on Feb. 24, 1839. At present the race at Aintree is four miles, 856 yards in length, with thirty jumps, some of spruce, others of fir, and many of them in combination with ditches and brooks. The jumps vary in height from four feet six inches to five feet two inches. The Grand National offers the largest purse of any steeplechase in the world, the value to the winner usually approximating $40,000. Because the stake is so high and the title so coveted, the Grand National attracts a large field (66 in 1929) of the finest-bred and fastest horses trained for steeplechasing. The large field and the fast pace at which the race is run cause many falls and provide the spectators with an exciting and spectacular race.

From the American point of view the most important Grand National was that of 1938, which was won by Battleship, a horse owned by Mrs. Marion du Pont Scott of Montpelier, Va. Battleship's success was remarkable for several reasons. Standing merely 15 hands 2 in., he was one of the smallest horses ever to win the Grand National. He was the second American-bred horse to win, the first being Rubio in 1908, a horse bred at the Rancho del Paso in California and shipped to England as a yearling. Battleship was the first stallion to win since Grudon in 1901. The only other American-owned horses that have won the Grand National are Sergeant Murphy in 1923 owned by Stephen Sanford, Jack Horner in 1926 owned by C. Schwartz, and Kellsboro Jack in 1933 owned by Mrs. F. Ambrose Clark.

Steeplechasing in England and Ireland is under the control of the National Hunts Committee which assigns dates for the various meetings, draws up rules for conducting races, and regulates owners, trainers, and jockeys. The committee is a more important organization in the sport of racing in the British Isles than any similar organization is in America because in England almost the entire winter racing season is devoted to steeplechasing. From the end of the Taunton meeting in November to the Lincolnshire Handicap on April 1, except for a few minor meetings in Ireland, all racing is over jumps. It follows, therefore, that the steeplechaser gets a much larger share of the racing pound in England than of the racing dollar in the United States, where steeplechases are sandwiched in between flat races during the summer season. Because British steeplechase horses have such high earning powers, the horses competing in England are usually superior to those seen in America, and the numbers considerably greater. The caliber of the horses that appear in the paddock before the running of the Grand National is comparable with that of the well-bred horses that go to the post for the major handicaps on the flat in America. By the same token, more attention is paid to breeding steeplechasers in England and particularly in Ireland, a country which has produced the largest number of Grand National winners.

During a typical season there were fifty-four meetings run under National Hunt rules, of which nineteen were in Ireland. Next to the Liverpool meeting at Aintree, which includes the Grand National and is held in late March, the most important meeting is the National Hunt meeting held

earlier in March at Cheltenham. The principal feature is the Cheltenham Gold Cup at three miles and two furlongs. Although the Cheltenham Gold Cup is highly prized, the race is usually worth considerably less in purse value than the Grand National.

In addition to steeplechases held under National Hunt rules there are point-to-point meetings which are held under the jurisdiction of the Masters of Hounds Point-to-Point Committee. These are organized by the different hunt clubs of Great Britain and are held over courses within the territory hunted by each pack, usually over a piece of natural country with the fences altered, if necessary, to provide proper obstacles over which to race. Point-to-point meetings are also held by various army regiments, although since England abolished its cavalry units there have been fewer of these. In 1934 there were 186 point-to-point meetings held between February 17 and May 5, with from three to six races at each meeting. Point-to-point races are confined to horses which are the bona fide property of the persons in whose names they are entered and horses which are certified as genuine hunters by the Master of a hunt recognized by the Masters of Foxhounds Association and have been regularly and fairly hunted during the current hunting season. These meetings, which provide some of the finest amateur sport in the world and are very popular, serve also as a proving ground for young horses that might afterwards go on to compete in the major steeplechases under National Hunt rules.

Practically all the obstacles found in British steeplechase courses are brush fences, which are either natural hedges or artificial jumps made of spruce, fir, or some similar material. The lower part of a fence is thick and solid, but the upper part is thinner so that when a horse hits a fence he will usually be slowed up without falling. Another type of obstacle is the hurdle fences, a modification of the wooden sheep hurdles frequently seen in the English countryside. These are low in height—about three feet—and are designed for horses of considerable speed that are only moderate jumpers. On some of the courses in Ireland, such as Punchestown, there are also stone walls and banks, but these are exceptional. Almost all courses are provided with a water jump consisting of a small fence on the take-off side and a stretch of water eight feet or more in breadth on the other side.

Steeplechasing is also popular in the British dominions of New Zealand and Australia, in India, and in continental Europe—in Germany, Hungary, Belgium, and particularly in France and Italy, where most of the courses and conditions of racing are much like those in England.

*FIELD OF ENTRIES TAKING THE OPEN JUMP IN THE GRAND NATIONAL STEEPLECHASE HELD ANNUALLY AT AINTREE, ENGLAND*

INTERNATIONAL NEWS PHOTO

**Steeplechasing in the United States and Canada.** Steeplechasing was introduced in North America in 1838 with a hurdle race for horses hunted with the Montreal Hounds. The race was run under the patronage of the Governor General, the Earl of Durham, son of the first earl, who, as Lord Darlington and Master of the Raby pack, was perhaps the greatest M.F.H. of his day. In 1842 the Toronto garrison organized the first cross-country event in that section. The oldest steeplechase still in existence in North America is the Woodbine Steeplechase Handicap, a race of 2½ mi., held under the auspices of the Toronto Jockey Club and run for the first time in 1882, the winner being Mr. J. P. Dawes's Rose.

Steeplechasing was brought to the United States by Canadians in 1865. The first steeplechase was held at Paterson, N. J., on June 27 over twenty-seven jumps at a distance of three miles. The first three places were taken by Canadian horses, and in November of the same year another steeplechase was held at Lincoln, Mass., which the Canadians also won. Harry Worcester Smith in his chapter on steeplechasing in the United States in *Racing at Home and Abroad* states that the first steeplechasing at Newport, R. I., was not instituted until 1877. A column in the periodical *Turf, Field, and Farm* for Sept. 8, 1866, reveals that August 30 of that year marks the beginning of the cross-country sport at Newport.

The first steeplechase to be held at a major race track

was run at Jerome Park near New York City in October 1869 and was won by Col. McDaniels' Oysterman Jr. The Pimlico track at Baltimore, Md., followed with a race on Oct. 28, 1873, and thereafter, tracks like Rockaway and Saratoga, N. Y., Churchill Downs at Louisville, Ky., and the New Orleans Fair Grounds followed with events which established steeplechasing as a regular attraction.

Steeplechasing at the major tracks and at the Hunt Race Meetings in the United States is governed by the National Steeplechase and Hunt Association which formulates rules for the conduct of the sport and maintains an office in New York City. Some of the principal steeplechase events and the years in which they were inaugurated are:

| | |
|---|---|
| Battleship Steeplechase Handicap—Pimlico (Maryland) | 1938 |
| Beverwyck Steeplechase Handicap—Saratoga (New York) | 1897 |
| Brook Steeplechase Handicap—Belmont Park (New York) | 1905 |
| Charles L. Appleton Steeplechase—Belmont Park | 1922 |
| Chevy Chase Steeplechase Handicap—Laurel Park (Maryland) | 1911 |
| Corinthian Steeplechase Handicap—Belmont Park | 1902 |
| Glendale Steeplechase Handicap—Aqueduct (New York) | 1907 |
| Grand National Steeplechase—Belmont Park | 1899 |
| International Steeplechase Handicap—Belmont Park | 1895 |
| Indian River Steeplechase Handicap—Delaware Park (Delaware) | 1938 |
| Manly Steeplechase Handicap—Pimlico | 1916 |
| Meadow Brook Steeplechase Handicap—Belmont Park | 1916 |
| North American Steeplechase Handicap—Saratoga | 1904 |
| Saratoga Steeplechase Handicap—Saratoga | 1906 |
| Shillelah Steeplechase—Saratoga | 1902 |
| Temple Gwathmey Memorial Steeplechase—Belmont | 1924 |

Of these the Grand National Steeplechase at Belmont Park usually has the largest purse.

Total purse distribution at the major tracks in a typical year was $793,480, which, when added to the $58,545 distributed at the Hunt Race Meetings makes a total exceeding $850,000. This was still small, however, compared to the total purse distribution for flat racing at the major tracks in the same year—$48,497,544. During that year there were 244 races over jumps, 258 owners, and 426 horses. Principal meetings on the basis of purses distributed were Belmont Park, Aqueduct, Pimlico, and Saratoga in that order. By far the most successful breeder of steeplechasers was Mrs. Marion du Pont Scott, whose stallions Battleship and Annapolis, both sons of Man o' War, have been particularly consistent in siring jumpers.

In addition to the races held at major race tracks, there are a number of race meetings held annually under the auspices of some of the hunt clubs, which are also under the jurisdiction of the National Steeplechase and Hunt Committee. The courses are usually located in the districts hunted by the foxhound packs and are laid over the natural countryside, which is usually hilly and rolling in contrast to the courses at racetracks. An exception is the United Hunts meeting which is held at Belmont Park on two days each autumn under the auspices of the United Hunts Racing Association for the hunts in the New York area. Profits from this meeting are large, and since the United Hunts is a nonprofit organization a considerable proportion of the revenue is generously donated to increase purses at the smaller meetings in less populous areas. Of the $58,545 distributed by the fourteen hunt meetings in a typical year, $32,000 was donated to eleven meetings by United Hunts. Other important steeplechase meetings are the Rolling Rock Meeting at Ligonier, Pa., those at Middleburg and Montpelier in Virginia, and at Rose Tree near Philadelphia, Pa.

Steeplechase courses at the major race tracks are very much like those of the English tracks under jurisdiction of the National Hunts Committee, with both brush and hurdle courses. The hunt-meeting courses are usually regulation brush, but occasionally hurdle courses are utilized. Another type of course, found only in the United States, is the timber course modelled after the post-and-rail fences found in the American countryside. The races over brush at hunt meetings are from two to three miles, and over timber, from three to four miles.

The most famous of all races at the hunt meetings is the Maryland Hunt Cup held by the Green Spring Valley Hunt over a four-mile course in the Worthington Valley near Glyndon, Md. It includes twenty timber fences, some of them nearly five feet in height, and is considered by many experts, some of whom have ridden in the Liverpool Grand National, to be the most difficult course in the world. This meeting has several other unique features; namely, the Hunt Cup is the only race run at the meeting; it is for amateur riders only; no purse is involved; no admission is charged; and there is no grandstand. Steeplechase enthusiasts come from all over the country on the last Saturday in April every year, and as many as fifteen to twenty thousand people have gathered on the hillsides along the course to see the running. A number of horses that have won the Maryland have done well in the Liverpool Grand National, notably Billy Barton, who won in 1926 and later ran second in the National in spite of a shoe twisted during the running of the race. Although the Maryland Hunt Cup was inaugurated in 1894 and run annually thereafter, it was not until 1939 that the cup, which is retained by the owner of a horse that wins three times, was won outright when Blockade, by Man o' War, turned in his third consecutive triumph. The cup was retained again by Winton and his rider-owner Stuart Janney, Jr., who won in 1942 and came back to win again in 1946 and 1947. A. M.-S.

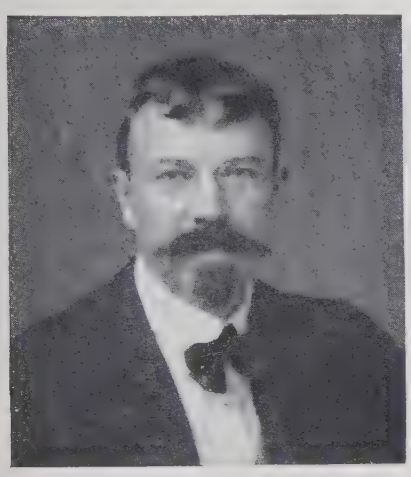
**STEFAN-BOLTZMANN LAW.** *See* HEAT AND THERMODYNAMICS (*Radiation*).

**STEFANSSON, VILHJALMUR** [stɛ'fɑnssɒn] (1879- ), Arctic explorer, was born of Icelandic parents in Arnes, Manitoba, Nov. 3, 1879. Educated at the University of Iowa and Harvard University, he went to Iceland in 1905 with a Harvard archaeological expedition. In 1906 he went on an ethnological expedition to the Eskimos at the mouth of the Mackenzie River and north Alaska, and between 1908 and 1912 he was a member of the longest Arctic expedition on record. Exploring the north of Canada and Alaska, this expedition studied the Eskimos and made investigations in the geographic sciences. From 1913 to 1918 he commanded the Canadian Arctic Expedition, which discovered the islands of Borden, Brock, Meighen, and Loughheed. He visited the Macdonnell Ranges of Central Australia in 1924, and from 1932 to 1945 he was adviser on northern operations for Pan American Airways. He has been Arctic consultant at Dartmouth College since 1947. In 1952 the Canadian Government named an Arctic island Stefansson Island in his honor. Author of many books, he also edited the U. S. Navy's *Encyclopedia Arctica*. S. Van V.

**STEFFENS, JOSEPH LINCOLN** [stɛ'fənz] (1866-1936), American journalist, was born in San Francisco, Apr. 6, 1866. Graduating from the University of California in 1889, he traveled in Europe and studied at the Universities of Berlin, Heidelberg, Leipzig, and Paris. Upon his return to the United States he took up newspaper work in New York City, serving as a reporter on the *Evening Post* from 1892 to 1897 and as city editor of the *Commercial Advertiser* from 1897 to 1902. He entered the magazine field in

1902 and for four years was managing editor of *McClure's Magazine.* In 1906 he and a number of associates purchased the *American Magazine,* but he resigned from that enterprise the following year and in 1910 joined the editorial board of *Everybody's Magazine.*

More important than Steffens' editorial work were the "muckraking" articles he wrote for *McClure's* and other crusading periodicals. The first decade of the century brought a flood of writing from such journalists as Ida Tarbell, Ray Stannard Baker, and David Graham Phillips, who, like Steffens, relentlessly exposed the political and economic corruption of American life and did much to build up the public sentiment necessary to achieve the reforms of the progressive movement. Steffens wrote two series of articles on corruption in city and state government, published in



JOSEPH LINCOLN STEFFENS

BROWN BROTHERS

book form as *The Shame of the Cities* and *The Struggle for Self-Government,* both of which created a sensation. Not content with revealing the facts, he strove to work out a theory of political corruption, finally concluding that it was an inevitable outgrowth of America's highly competitive economic system.

Steffens became increasingly interested in the labor problem and in 1911 intervened in the trial of two labor leaders, the McNamara brothers, who were accused of dynamiting the Los Angeles *Times* building. He was equally concerned with the comparative merits of reform and revolution as techniques of social progress. During the years 1914 to 1916 he made two trips to Mexico to observe the progress of the revolution in that country, and in 1917 to 1918 he made two trips to Russia, the second as a member of the Bullitt mission. He was favorably impressed by the Communist achievements. Subsequently he was present at the Paris Peace Conference in 1919 and made extensive lecture tours in the United States, speaking on labor questions and on his Mexican and Russian observations. During the 1920's Steffens felt that expanding American capitalism was pointing an evolutionary way to a future of abundance. With the coming of the depression of the 1930's, however, he became convinced that revolution was the only way to make "all reforms" possible and that "Communism has to come." His *Autobiography* (1931) became an American classic because of its significant picture of three decades of reform and revolution, its provocative ideas, and its vigorous style. During the last ten years of his life, from 1927 to 1936, he wrote weekly columns for various California journals, including *The Carmelite, Controversy,* and *Pacific Weekly;* these were collected in book form under the title *Lincoln Steffens Speaking.* He died at Carmel, Calif., Aug. 9, 1936. R. E. N.

**STEGOCEPHALIAN.** *See* PALEONTOLOGY (*Vertebrate Paleontology*).

**STEIERMARK.** *See* STYRIA.

**STEIN, GERTRUDE** [stai'n] (1874-1946), American author, was born Feb. 3, 1874, in Allegheny, Pa. Her early life was spent in Europe and in California. She studied psychology with William James at Radcliffe, and later brain anatomy at Johns Hopkins University. In 1903, with a companion, Alice B. Toklas, she settled in France, where she remained until her death, except for a visit to the United States in 1934. In Paris she was the focus of the most advanced group of painters and writers, becoming the friend and patron of Picasso and Matisse, and exerting strong influence upon such American writers as Sherwood Anderson and Ernest Hemingway. The basis of her extraordinary influence lay in her experiments with language. Believing that "the business of art" is to live in "the complete actual present," she sought to achieve this effect in her writing by the use of partly repetitive statements, each representing some accretion of meaning, so that experience could be presented as it actually impresses itself upon consciousness. This aspect of her style was related to her experiments in automatic writing at Radcliffe. It represented a conscious abandonment of the rhythm and structure of literary prose in favor of the rhythm and structure of ordinary speech. Her writings in fiction included *Three Lives* (1909) and *Lucy Church Amiably* (1930). *Tender Buttons* (1914) was a volume of poetry in which she put into practice her theory that poetry is "really loving the name of anything," i.e., expressing vividly the actual qualities of things. Two autobiographical works were entitled *The Autobiography of Alice B. Toklas* (1933) and *Everybody's Autobiography* (1937). Her literary theories were set down in *How to Write* (1931) and *Lectures in America* (1935). In 1934 her opera *Four Saints in Three Acts* (musical score by Virgil Thomson) was successfully performed in America. She died at Neuilly on July 27, 1946. A posthumous novel, *Things as They Are,* was published in a limited edition in 1950. F. B. T.

**STEIN, BARON HEINRICH FRIEDRICH KARL VOM UND ZUM** [shtai'n] (1757-1831), German statesman, was born near the town of Nassau, Oct. 26, 1757. After studying law at the University of Göttingen, he entered the Prussian governmental service in 1780. He held several minor posts in the government before coming minister of mines in 1796. In this capacity he helped to develop the coal resources of the Ruhr Valley by improving the inland transportation facilities in Germany. He had the Ruhr canal system constructed and did much to improve road and river travel. Stein continued to hold office in the government but became widely known for his advocacy of changes and reforms in its administration. After Napoleon's crushing defeat of the Prussians at Jena in October 1806, a governmental change was in order and Stein was appointed prime minister in October 1807. He at once issued the Edict of Emancipation, which abolished serfdom in Prussia. He also did much to promote land reform and weaken the monopolistic hold that certain classes had on various professions and occupations. Stein reorganized the cabinet and instituted local self-government in the municipalities. His career as prime minister, auspicious as it was, was brief. One of his letters indirectly attacking Napoleon and professing hope for the liberation of Germany fell into the hands of the French. Threatened by Napoleon, Stein was forced to

resign and fled to Austria little more than fourteen months after he had taken office. In 1812 he went to Russia where he was an adviser to Tsar Alexander I during the Napoleonic invasion. After Napoleon's defeat, the Russians made Stein administrator of various recaptured territories. The erstwhile Prussian premier continued to work for the complete liberation of the German states and the establishment of a unified nation. His plans for a united Germany were defeated by Metternich and others at the Congress of Vienna in 1815, and Stein went into virtual retirement, during which he devoted himself to the study of history. Stein's practical nature and great energy were excellent complements to his social and political views. His study of the English enlightenment movement and the ideas of the French Physiocrats led him to believe firmly in humanitarian and governmental improvement. He was profoundly influenced by the first reforms of the French Revolution but deplored the violence with which these changes were effected. Stein died at Kappenberg, Westfalia, June 29, 1831. R. H. L.

**STEINBECK, JOHN ERNST** [stai'nbɛk] (1902- ), American novelist and short-story writer, was born at Salinas, Calif., on Feb. 27, 1902. He attended Stanford University at intervals between 1919 and 1925, worked at various jobs, and came to know intimately the farmers, migratory workers, and *paisanos* of whom he has chiefly written. Steinbeck's first novel, *Cup of Gold* (1929), based on the career of the pirate, Sir Henry Morgan, contained the romantic element that has ever since been discernible in his naturalism. Other manifestations of his romantic and sentimental tendencies can be seen in *To a God Unknown* (1933), concerned with pagan fertility-worship and the life force in nature; in *The Grapes of Wrath* (1939), his most popular and generally considered his best work, concerned with the migration and the later fate in California of Oklahoma sharecroppers and tenant-farmers who were driven from their land by the depression and the drought of the 1930's; and in his sympathy with strong, simple, natural men in *Of Mice and Men* (1937), *Cannery Row* (1946), *The Wayward Bus* (1947), and most of his other works.

These idealistic and emotional elements in Steinbeck's work connect him with the romantic naturalism of Emerson and Whitman, while scientific naturalism may be seen in comparatively pure form in the collections of short stories, *Pastures of Heaven* (1932), *Saint Katy the Virgin* (1936), *The Red Pony* (1937), and *The Long Valley* (1938), which contain some of the finest things the author has done. Steinbeck reached the high point of his fame as the chief proletarian novelist of the 1930's, a writer whose naturalistic objectivity of presentation was mingled with a great tenderness for the submerged and inarticulate masses, one of whose spokesmen he became. With the ebbing of the proletarian reform spirit of the 1930's, his work, although widely published and read, has seemed to many to lose certainty and direction. H. H. W.

**STEINBOK** or **STEENBOK** [stai'nbɒk; sti'nbɒk], a small antelope of the genus *Raphicerus* of southern and east central Africa. It is reddish or buff, white on the belly and legs, and measures about 22 in. high at the shoulders. Bucks and does have spikelike horns which are 3 to 5 in. long. Very speedy, they may crouch close to the ground until almost stepped upon before taking flight. Normally a resident of dry grassy plains, steinboks sometimes live in open forest. *See also* ANTELOPE. V. H. C.

**STEINDORFF, GEORG** [shtai'ndɔrf] (1861-1951), German Egyptologist, was born in Dessau, Germany, on Nov. 12, 1861. He studied from 1881 to 1884 at the universities of Berlin and Göttingen, and received his doctoral degree at Göttingen in 1884. He became the Assistant Curator of the Berlin Museum in 1885, and Professor of Egyptology at Leipzig in 1893. As a refugee from Nazism, he came to the United States in 1939, becoming a citizen in 1944. Steindorff's numerous contributions to Egyptology concern language, art, archaeology, history, religion, and travel, and they range from extremely technical investigations to highly successful popularizations. Steindorff's greatest scientific accomplishment is his *Koptische Grammatik* (1894), of which a third edition was completed; several generations of Coptic scholars have been brought up on this work. Steindorff's most widely read book is probably Baedeker's *Egypt and the Sudan,* of which he was editor and to which he contributed. His illustrated book on Egyptian art, *Die Kunst der Ägypter* (1928), is a good example of his ability to do sound and useful work for a wide public, while one of his most readable and interesting books, on a semipopular plane, is *When Egypt Ruled the East* (1942), written jointly with Professor Keith C. Seele. He later produced the *Catalogue of the Egyptian Sculpture in the Walters Art Gallery* (1946), a handsome and definitive publication of a rich collection that had hitherto been unknown to the scholarly world. Steindorff died in North Hollywood, Calif., on Aug. 28, 1951. C. H. Go.

**STEINMETZ, CHARLES PROTEUS** [stai'nmɛts; shtai'nmɛts] (1865-1923), German-American electrical engineer, was born a hunchback in Breslau, Germany, on Apr. 3, 1865. He studied at the University of Breslau and later attended the Polytechnic Institute in Zürich and wrote articles on astronomy. Forced to leave Germany because of a socialistic editorial that he wrote for a Breslau newspaper, he emigrated to America in 1889. He found employment as an electrical draftsman in Yonkers, N. Y., for Rudolf Eickemeyer, a hat manufacturer who was also an inventor and greatly interested in electricity. Steinmetz's genius soon became apparent. In 1892, at a meeting of the American Institute of Electrical Engineers, he gave a talk in which he elucidated the exact law of hysteresis. His findings showed that, within certain limits, the energy loss due to cyclic magnetization of a piece of iron or steel (hysteresis loss) is proportional to the 1.6th power of the maximum flux density attained in the iron. This knowledge made it possible to calculate in advance the losses in power resulting from this effect and placed the design of transformers and alternating-current motors and generators on a much firmer theoretical basis.

In 1893, Steinmetz became an engineer for the General Electric Co. in Schenectady, N. Y. He was a tireless worker, and as a result of his discoveries more than 200 patents were obtained by the General Electric Co., among them an aluminum lightning arrester to protect high-tension transmission lines, the magnetite arc lamp, and numerous improvements on generators and motors. He investigated the phenomenon of lightning, was interested in the wireless, and did much to establish alternating-current theory. In his later years Steinmetz helped to disprove the existence of the ether and had high praise for Einstein's relativity theory. He was elected president of the American Institute of Electrical Engineers in 1901. One year later he was appointed professor of electrical engineering at Union College, a position which he undertook in addition to his work with General Electric. He was the author of a number of books, including *Radi-*

*ation, Light and Illumination* (1909), *Engineering Mathematics* (1910), and works on electric discharges, relativity and space, and other subjects.

In his book *America and the New Epoch* (1916), Steinmetz expressed the view that private ownership would eventually yield to government ownership under private management. In 1922, he ran for state engineer on the Socialist ticket but was defeated. Steinmetz died in Schenectady on Oct. 26, 1923. I. B.

**STEINTHAL, HEYMANN** [shtai'ntɑl] (1823-1899), German linguist, was born May 16, 1823, at Gröbzig, in Anhalt. He studied philology and philosophy in Berlin from 1843 onward, became *Privatdozent* in that city in 1850, studied Chinese in Paris from 1852 to 1855, and in 1863 was nominated extraordinary professor at the University of Berlin. He died in Breslau on Mar. 14, 1899.

Steinthal combined some theories of Wilhelm von Humboldt and J. F. Herbart into a system of his own. Anthropology, he said, investigates the group of phenomena which lie between the physiological and psychological phenomena; ethnology investigates the spiritual life of nonhistorical peoples; and linguistics, the rules of parallel development within the various linguistic groups. Man, in contrast to animals, has produced culture and especially science. The latter originated out of a stage of higher morality and contributed to the development of a higher culture, especially to the concept of humanity. Progress, he felt, occurs slowly and cannot be accelerated artificially by revolution. The evolutionistic anthropological school of Adolf Bastian considered Steinthal's theories, as well as those of Moritz Lazarus and Theodor Waitz, as congenial; while the cultural-cyclical school of Wilhelm Schmidt rejected them.

Steinthal is, after Wilhelm von Humboldt, the most important representative of the Romantic school of linguistics. He stressed the role of the individual in the linguistic process and that of the nation as a whole in the shaping of its own particular language. The origin of language he saw in the progressive identification of sensations and impulses with the movements of the body and of the vocal chords. Devoting much effort to works of linguistic theory and philosophy, Steinthal followed the speculative idealistic trend of the Romantic period, and as respect for his ideas revived in the twentieth century, his work largely inspired the so-called neo-Romantic school of linguists, constituted mainly by E. Cassirer, W. Porzig, and Leo Weisgerber.

Among Steinthal's most important publications are *Die Sprachwissenschaft W. v. Humboldts und die hegelsche Philosophie* (1848), *Die Classification der Sprachen dargestellt als die Entwicklung der Sprachidee* (1850), *Der Ursprung der Sprache im Zusammenhange mit den letzten Fragen alles Wissens* (1851), *Die Entwicklung der Schrift* (1852), *Grammatik, Logik, Psychologie, ihre Prinzipien und ihr Verhältnis zu einander* (1855), *Charakteristik der hauptsächlichsten Typen des Sprachbaus* (1860), and *Geschichte der Sprachwissenschaft bei den Griechen und Römern* (1863). G. B. and P. H.

**STELE** or **STELA** [sti'li, sti'lə], a free-standing or, by extension, an engaged vertical tablet, which may be inscribed or decorated, and which is used for civic, religious, or commemorative purposes. In Egyptian tombs a vertical panel in the chamber wall, sometimes including a portrait of the deceased with hieroglyphic descriptions, is often called a "false door" because it resembles a domestic doorway; this stele may have represented an exit for passage of the spirit.

Greek gravestones, carved in low or medium relief, were often made in the form of a stele, with a figure representing the deceased or a group showing the deceased taking leave of family or friends. These were crowned with a pediment or anthemion. In Chinese tombs and temples, inscribed stelae mounted on the backs of turtles have a dragon figure across the top. L. R.

In the Western Hemisphere stelae are restricted to stone columns or monuments which were erected in prehistoric times in the Mayan area. For the most part they date from c. 300 to 1000 B.C. Some of these stelae are undecorated, although they may once have borne painted inscriptions or decorations. Those of greatest interest have hieroglyphic carvings in relief. These stelae glyphs have been translated, in part, and represent commemorative dates in the Mayan time-counting system, plus additional material of perhaps a historical or mythical nature. G. R. W.

**STELLAR MAGNITUDE.** Magnitude, in astronomy, indicates the brightness of a star or other celestial object. It does not refer to actual size. Early astronomers divided naked-eye stars into six magnitude classes. About twenty of the brightest stars were in magnitude 1, and the faintest stars visible under good conditions were in magnitude 6. Modern astronomers use the same system, somewhat revised. Fractional magnitudes are used; the very bright stars are assigned negative magnitudes. Telescopes can reach to magnitudes beyond 21. Thus, the fainter the star, the larger the positive value of magnitude.

The ratio of brightness between two stars differing by just one magnitude is the light ratio. This is approximately the number 2.512, the logarithm of which is 0.4. If the difference of two magnitudes is $m—n$, the light of two stars $l_n$ and $l_m$, and the ratio of apparent brightness $\frac{l_n}{l_m}$, the following relation holds:

$$\frac{l_n}{l_m} = (2.512)^{m-n},$$

which may be simplified to:

$$\log \frac{l_n}{l_m} = 0.4(m-n),$$

either form being useful in working magnitude problems. Thus, a difference of 3.0 magnitudes gives a light ratio of 15.85, and a difference of 5.0 magnitudes a light ratio of 100.0. Since there is a difference of 5 magnitudes between magnitudes 1 and 6, a star of magnitude 1.0 is 100 times as bright as one of magnitude 6.0.

There are several ways of using magnitude. The magnitude of an object as seen in the heavens is the apparent visual magnitude (apparent in contrast to absolute, and visual in contrast to photographic). The same system applied to photographic images on ordinary plates gives the photographic magnitude. The visual- and photo-magnitude scales agree for stars of class Ao and visual magnitude 6.0. But blue stars are brighter photographically than visually on ordinary photo plates, whereas yellow and red stars are dimmer. The difference between the photo and the visual magnitude is the star's color index:

color index = photo mag. — visual mag.

When photographs are made with color-sensitive film and filters giving color-correct results, the photo-visual magni-

tude is obtained. Apparent magnitudes of stars range from —1.58 (visual) for Sirius to + 21 or more (photo magnitude) for faint stars photographed with the largest telescopes. On this standard scale, the full moon is of magnitude —12.5, and the sun —26.7, while Venus may reach —4.4. Aldebaran's magnitude is +1.06, and that of Polaris is +2.12.

The apparent magnitude depends upon the object's own or intrinsic brightness and its distance, for, if the brightness itself is constant, the greater distance causes it to become fainter. Consequently, it is desirable to utilize the term absolute magnitude, which is the apparent magnitude of a star removed to a distance of 32.6 light years (10 parsecs), where the parallax is 0″.1. The range of absolute magnitude goes from —5 to +19.5 or more. The sun's absolute magnitude is +4.85. The absolute magnitude may be visual, photographic, or radiometric. The relation of the parallax, $p$, the observed apparent magnitude, $m$, and the absolute magnitude, $M$, is given by:

$$M = m + 5 + 5 \log p''$$

Inasmuch as many stars would far outshine the sun if at the same distance, it is important to know a star's intrinsic luminosity compared to the sun's; this is given by:

log of luminos. of star = 0.4 (4.85 — abs. mag. of star).

A radiometric magnitude is one determined with the thermocouple, a heat-measuring device sensitive to all radiations. The heat index of a star is obtained by the formula:

heat index = visual mag. — radio. mag.

H. S. R.

**STELLARTON** [stɛ′lərtən], a town in Pictou Co., Nova Scotia, Canada, situated on the west bank of the East River of Pictou Harbour, about 75 mi. northeast of Halifax, on Provincial Highway 4. It is served by the Canadian National Railways. The town was incorporated in 1889. Coal mining, begun in 1798, is its chief occupation. Approximately 400,000 tons per year are produced. Pop. 1951, 5,575. D. F. P.

**STEM.** *See* Plant Anatomy.

**STENCILING.** *See* Printing and Graphic Arts (*Graphic Arts*).

**STENDHAL (MARIE HENRI BEYLE)** [stãⁿ′da′l, be′l] (1783-1842), French novelist and critic, was born on Jan. 23, 1783, at Grenoble, of an upper-middle-class family. As a child he made excellent progress in mathematics at the Ecole Centrale, in Grenoble. At the age of sixteen, he left Grenoble for Paris, intending to enter the Ecole Polytechnique and study mathematics. Once in Paris, however, he joined the army of Napoleon, attaining in 1801, in Italy, the rank of second lieutenant. While his military experience was brief, his impressions of Italy were responsible for his lifelong Italophilia. In 1805 he followed the actress Mélanie Guilbert to Marseille, where he became a clerk in a grocery store. His passion for Mélanie cooled and he returned to Paris in 1806. There, aided by his influential cousin, Pierre Daru, he was appointed a commissar in the Napoleonic armies. He served the emperor from 1806 to 1814, being one of the survivors of the retreat from Moscow. After the fall of Napoleon, he went to Milan, where, between 1814 and 1821, he lived a life devoted to love and political intrigue. He made his literary debut in 1814, publishing, under the pseudonym of Louis Alexandre César Bombet, *Vie de Haydn, de Mozart, et de Métastase,* in which he plagiarized an Italian writer. He continued with *Histoire de la peinture en Italie* (1817) and *Rome, Naples, et Florence* (1817). He was suspected as a *carbonaro* by the Austrian police in Milan and, fearing imprisonment, he returned to Paris, where he published in rapid succession: *De l'amour* (1822), a treatise on love, partly pseudo-scientific and partly anecdotal; *Vie de Rossini* (1824); and *Racine et Shakespeare* (1825), a plea for "romanticism" against "classicism." His first novel, *Armance* (1827), though weak, already suggests the interest of the author in the psychological self-analysis of his characters. After *Promenades dans Rome* (1829), there appeared, in 1830, the first of his two masterpieces, *Le Rouge et le Noir,* a novel in which the author reveals his extraordinary skill in the analytical and dynamic treatment of human behaviour.

STENDHAL
(MARIE HENRI BEYLE)

CULVER SERVICE

In 1830 Metternich refused to accept Stendhal as a French consul at Trieste, but in 1831 Stendhal became consul at Civitavecchia, a post he held to the end of his life. After his *Mémoires d'un touriste* (1838), Stendhal published *La Chartreuse de Parme* (1839), his second masterpiece, an absorbing novel in which character analysis, passionate affirmation of life, and intricate political intrigue blend in one of the finest works in fictional art. While on a visit to Paris Stendhal suffered an attack of apoplexy and died, Mar. 23, 1842.

With the gradual increase of Stendhal's reputation there began the posthumous publications of his unpublished manuscripts. Important among them are *Vie de Henri Brulard* (1890) and *Souvenirs d'égotisme* (1892), autobiographical sketches remarkable for their revelation of Stendhal's complex personality; *Lucien Leuwen* (1855), an unfinished novel, exposing some of the political evils existing during the reign of Louis Philippe; *Vie de Napoléon* (1876) and *Mémoires sur Napoléon* (1854); and *Chroniques Italiennes* (1929).

Stendhal's chief contribution to literature is his development of the analytical novel, in which his characters constantly indulge in pitiless psychological soliloquies in their passionate desire to understand their own actions and the reactions of the world around them. But his drily trenchant style, modeled after the *idéologues* of the eighteenth century and the "civil code," was repellent to his romantically effusive contemporaries. Only Balzac sensed his greatness. Stendhal's prophecy that he would be appreciated in 1880 or later came true. He is now considered one of the greatest French novelists. *See also* Rouge et le Noir, Le. M. Br.

**STENOGRAPHY.** *See* Shorthand.

**STENTOR,** a genus of Protozoa in the class Ciliata, so-called because of its trumpet-shaped body which is com-

pletely covered with cilia of uniform size. Species are found in fresh water as free-swimming or sessile (attached) organisms. Their bodies are highly contractile because of the well-developed internal fibrils (myonemes). They are comparatively large, 0.3 to 3 mm. long, and can be seen with the naked eye by a trained observer. Some are colorless whereas others are yellow, brown, rose, blue, or blue-green. The blue color is due to a pigment called stentorin. *Stentor coeruleus, S. polymorphus, S. mulleri,* and *S. amethystinus* have symbiotic algae, *Zoochlorella,* living within their bodies. R. F. N.

**STEPHANSSON, STEPHAN G.** [stɛ'fɑnssɒn] (1853-1927), Icelandic-Canadian poet-farmer, was born at Kirkjuhóll, Skagafjördur, Oct. 3, 1853, and came to the United States in 1873, finally settling in Alberta, Canada, in 1889. Stephansson had read the Icelandic sagas and the Eddas as a boy and had had no other schooling; yet he became one of the greatest poets of Iceland in his day and is considered by some the greatest poet in Canada. He made his debut in 1898. His collected poems, *Andvökur* ("Wakeful Nights"), were published in six volumes from 1909 to 1939; the title reveals his working hours. A realist, Stephansson was anticlerical and anticapitalistic, a great individualist, and an ardent lover of nature; visions of the natural beauty of America and Iceland rise from the pages of his poems. His poetry is intellectual, lyrical, and rich in Norse symbolism. He died Aug. 10, 1927, on his Alberta farm. S. E.

**STEPHEN, ST.** (died c. A.D. 35), the first Christian martyr, is known from the account of him in the sixth, seventh, and eighth chapters of the *Acts of the Apostles.* Of Jewish extraction but Greek culture, one of the first seven deacons chosen by the apostles, he was an especially gifted preacher and did "great wonders and signs among the people." Brought to trial before the Sanhedrin, Stephen so eloquently defended his preaching and so roundly condemned certain Jews that his enraged judges immediately cast him out of the city and stoned him. "Falling on his knees, he cried out with a loud voice, saying 'Lord, do not lay this sin against them.' " Stephen's feast day is December 26. W. C.

**STEPHEN I, ST.** (c.200-257), pope, was a Roman. His pontificate (254-257), while not disturbed by civil persecution, was a time of great internal strife. In the struggle about the rebaptism of those baptized by heretics, Stephen, acting explicitly as successor of St. Peter, ordered that in accord with the tradition of the Roman Church such persons should not be rebaptized, baptism by heretics being held valid. On this issue he broke with the North Africans under Cyprian as well as with some churches of Asia Minor. Although he died at the beginning of the Valerian persecution, Stephen was not a martyr. E. A. R.

**STEPHEN III** (c.690-757), pope, succeeded Stephen II in 752. Inasmuch as Stephen II died without being consecrated, a few days after his election to the papacy, some writers omit him from the list of popes and give the title Stephen II to his successor.

During the pontificate of Stephen III the Papal States were founded, an event of importance in world history. Stephen was forced by his difficulties with the Lombards to cross the Alps—the first time a pope made the journey—to ask aid of Pepin the Short, Frankish king by the grace of Pope St. Zachary. In 754 Pepin promised to make the pope a temporal ruler, and, in 756, after a successful military expedition against the Lombards, Pepin presented to Stephen the states he had won from the Lombards, laying the keys to their cities on the tomb of St. Peter. Stephen died April 26, 757. E. A. R.

**STEPHEN** (c. 1097-1154), King of England, third son of Stephen Henry, Count of Blois and Chartres, and his wife, Adela, daughter of William I, was born in Normandy about 1097. He was brought up and educated by his uncle, Henry I of England. After the death of Henry's son, William, in 1120, Stephen was regarded as the logical heir to the throne, but in 1125 he swore, with the lay barons, to acknowledge Henry's daughter, the widowed Empress Matilda, as heir of England and Normandy. However, on Henry's death in 1135, Stephen claimed the throne and, sailing for England, was chosen king by the Londoners and crowned at Westminster, Dec. 25, 1135. In 1136 he bought off the king of the Scots, David I, who had invaded Northumberland, issued two charters of liberties, and crushed a rebellion of the barons. The following year he made a truce in Normandy with Matilda's second husband, Geoffrey of Anjou, and repelled a second Scottish invasion.

In 1138 the barons, alienated by Stephen's extravagance and use of foreign mercenaries, rose in revolt, and in the same year the clergy turned against the king after he had arrested and dealt harshly with the bishops of Salisbury, Lincoln, and Ely. After permitting Matilda to join her half-brother, Robert, Earl of Gloucester, at Bristol in 1139, Stephen lost the western shires to the empress. At the Battle of Lincoln in 1141 he was defeated and captured by Gloucester, and for six months Matilda reigned as sovereign. Her harsh rule, however, soon turned the tide against her, and in November 1141 Stephen was released and again declared king. Until 1148, when Matilda withdrew from England, Stephen was engaged in a constant struggle against the empress and her supporters, and was unable to prevent the conquest of Normandy by Geoffrey of Anjou in 1141. He also had again incurred the displeasure of the Church and in 1152 was unable to secure papal sanction for the coronation of his son Eustace as his successor. When Matilda's son Henry, Duke of Normandy (afterwards Henry II), invaded England in 1153, Stephen, disheartened by the long struggle and the death of his wife, Matilda of Boulogne, and their son Eustace, signed a treaty at Wallingford (1153) acknowledging Henry as heir to the throne. He died at Dover, Oct. 25, 1154. C. W. D.

**STEPHEN** (Hung. István), the name of five kings of Hungary, the two most important of whom were as follows.

**Stephen I** (c. 975-1038), known as Saint Stephen, first king of the Árpád Dynasty, was the son of Géza, Duke of Hungary. He married Gisela of Bavaria in 996 and the following year, on the death of his father, succeeded to the ducal authority. A convert to Christianity, Stephen defeated a pagan rebellion under Kopány in 998 and received papal recognition in 1000. In 1001 he was crowned apostolic king with a crown sent by Pope Sylvester II. Stephen's reign was marked by a series of struggles against the heathen nobles and by his attempts to impose Christian reforms on the Magyars. He founded several bishoprics and monasteries and divided his kingdom into forty-five counties, becoming the first organizer of political life in Hungary. In 1030 Stephen successfully repulsed an invasion by the emperor Conrad II. He died in 1038 and was canonized in 1038.

**Stephen V** (1239-1272) was the eldest son of Béla IV. As crown prince, he forced his father to divide the kingdom and to share the royal authority with him. Invading Bulgaria in 1268, Stephen established himself as king of the

Bulgarians. He succeeded his father to the throne of Hungary in 1270, and in 1271 repelled an invasion of the kingdom by Ottokar II of Bohemia. He died suddenly in 1272.
C. W. D.

**STEPHEN, SIR LESLIE** (1832-1904), English biographer, philosopher, and man of letters, was born in London, Nov. 28, 1832. A precocious child, he was educated at home and at Eton, and attended King's College, London, and Trinity Hall, Cambridge. After being ordained in order to hold academic positions, he rejected the historical evidences of Christianity in 1862 and in 1870 relinquished orders, justifying his course in *An Agnostic's Apology* (1876). As a professional writer he contributed to many periodicals, wrote numerous lives for the "English Men of Letters" series, edited the *Cornhill Magazine* (1871-1882), and crowned his biographical activities by editing the *Dictionary of National Biography* (1882-1891). His essays were collected as three series of *Hours in a Library* (1874, 1876, 1879) and as two series of *Studies of a Biographer* (1899, 1902). He did distinguished work in historical economics and political philosophy in *A History of English Thought in the Eighteenth Century* (1876) and *The English Utilitarians* (1900). His personal attitudes are expressed in *A Science of Ethics* (1882). Virginia Woolf, the novelist, was his younger daughter. Stephen died in London, Feb. 22, 1904.
W. C. He.

**STEPHEN NEMANYA** [nɛ'mɑnyɑ] (*Serb.* Stevan Nemanja), the name of a series of rulers of Serbia, the Nemanyan Dynasty, which extended from 1168 to 1371. The house was founded by Stephen Nemanya (1114-1200), the Serbian grand zupan (chief), who ruled from 1168 to 1196 and was the first to bring a measure of unity to the Serbs as a means of resisting Turkish territorial encroachments. In 1196 he resigned his rule and joined his oldest son (St. Saba) at the monastery he had founded on Mt. Athos, where he died four years later. He was succeeded by another son, who was crowned by papal authority in 1217 as Stephen Nemanya I (d. c. 1228).

The most famous of the line was Stephen Urosh IV, Nemanya IX, known as Stephen Dushan or Dušan (c. 1308-1355). In 1331 he rebelled against and imprisoned his father, Stephen Urosh III, Nemanya VIII (d. 1334), who is accounted a saint by the Serbian church although he has never been canonized. A great warrior and statesman, Stephen Dushan attempted to form a Serbo-Greek empire on the Balkan Peninsula in order to prevent Turkish invasion of the then disorganized Byzantine Empire. Toward this end he took Albania, Epirus, Thessaly, and all of Macedonia but Salonika. Crowned king of Serbia in 1335, in 1345 he was proclaimed emperor of the Serbs, Greeks, Bulgars, and Albanians. Between 1349 and 1354 he had the parliament draw up the Code of Dushan, which was used as the foundation of later Serbian legislation. In 1350 he took Bosnia. Preparing to lay siege to Constantinople, he died suddenly under suspicious circumstances on Dec. 20, 1355.

Stephen Urosh V, Nemanya X (1336-1371), was the son of Stephen Dushan and the last of the line. After Dushan's death, the provincial rulers revolted and the Turks took advantage of this disorganization to enter his lands. His army was defeated by the Turks on the Maritsa River, and two months later, in November 1371, Stephen died.
R. T.

**STEPHENS, JAMES** (1882-1950), Irish author and a leading member of the Irish Academy of Letters, was born in Dublin, Feb. 2, 1882. He is described by Frank Swinnerton in *The Georgian Scene* as small and slight with "the face of one who dwells . . . in a world mocked and twisted by fairies." Emerging from a poverty-hounded youth, he became a contributor to *Sinn Fein* and a protégé of George Russell several years before publishing his first book, *Insurrections* (1909), a volume of verse. He was co-founder (1911) of *The Irish Review,* wherein appeared his first novel, a reflection of Dublin tenement life issued in book form in 1912 as *The Charwoman's Daughter* (American title, *Mary, Mary*). He won the 1912 Polignac Prize with *The Crock of Gold,* a prose fantasy, and the Tailltean Gold Medal with *Deirdre* (1923), a romance. After a sojourn in Paris from about 1912 to 1916, he returned to Dublin to serve as registrar of the National Gallery of Ireland until 1925, when he began a series of annual lecture tours in America. Subsequently, though a vigorous Nationalist, he lived largely in suburban

*JAMES STEPHENS*

BROWN BROTHERS

London, where he had married in 1917, maintaining his fabulous reputation as a conversationalist and occasionally doing radio broadcasts.

At times a derivative versifier, though subtle as a critic and suggestive of affinities with Synge and Gissing, Stephens perhaps achieved his greatest originality and poetic effectiveness in the following works: *The Crock of Gold; Here Are Ladies* (1913), a compound of story, essay, and verse; *The Demi-Gods* (1914), a wildly beautiful tale of tinkers and of angels masquerading as mortals; *Etched in Moonlight* (1928), a collection of short stories; and certain incomparable lyrics, most of which can be found in *Collected Poems* (1926) and *Kings and the Moon* (1938). However, Stephens' reshaping of Fenian tradition in *Irish Fairy Tales* (1920) and of matter from the ancient Ulster story-cycle in *Deirdre* and *In the Land of Youth* (1924), a volume containing two tales, each of novelette length, put to use a pace, a naturalness, and a magical quality rarely found in English prose. Perhaps the secret of Stephens' art lies partly in his early recognition of writing as "a way of being"; his caprice, which often is less real than apparent; his humor, frequently ironic, but nourished by an essentially religious concept of joy; and his vitality, to which a remark in *The Demi-Gods* gives the key: "There was no old age in that man's mind." Stephens died in London on Dec. 26, 1950.
G. B. S.

**STEPHENS, JOHN** (fl. c.1615), English satirist and a member of a politically prominent Gloucester family. From 1611 forward he practiced law in London without evidently achieving unusual success. His contribution to literature is his *Satyrical Essayes, Characters, and Others* (1615), a volume

of short character sketches containing historically interesting details, especially in portraits with a background of law. He joined with Joseph Hall, Sir Thomas Overbury, and John Earle in effecting the nationalization of the Theophrastan character in England, but in contrast with most character-writers, he showed an ability to discern traits which set individuals apart from types. *See also* CHARACTER. M. L. MacL.

**STEPHENSON, GEORGE** (1781-1848), English inventor and pioneer in railroading, was born in Wylam, near Newcastle, on June 9, 1781. In 1795 he became assistant fireman to his father, a miner at Dewley colliery, and in his spare time he repaired watches and clocks, his mechanical ability earning for him the position of enginewright at the Killingworth mine in 1812. Stephenson had made a study of the steam engine of James Watt, and in 1813 he received

GEORGE STEPHENSON

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financial backing to construct a steam locomotive. On July 25, 1814, this locomotive, named the *Blücher,* made a successful trial run. In 1815 Stephenson patented the steam blast, a device to increase the draft in the boiler, and invented a safety lamp for miners at about the same time that Sir Humphrey Davy invented his safety lamp; for years there was controversy as to who had prior claim to this invention.

Stephenson supervised the construction of an 8-mi. railway for the Hetton colliery, begun in 1819 and completed in 1822, and in 1823 he founded a locomotive factory in Newcastle. In 1825, for the Stockton and Darlington Railway, Stephenson built a locomotive weighing eight tons and having a top speed of 16 m.p.h. He next served as construction engineer to the Liverpool and Manchester Railway, overcoming formidable natural obstacles in building the roadbed. The sponsors of this railway declared an open competition to choose a locomotive, with a prize of £500, which Stephenson won at Rainfall in 1829 with his engine the *Rocket,* covering 12 mi. in 53 minutes. The railway was opened one year later. Stephenson was consulted in the planning of numerous railways in the years that followed and served as chief engineer for the Manchester to Leeds, Birmingham to Derby, Derby to Leeds, Normanton to York, Sheffield to Rotherham, and other railways. He also helped build railways in Belgium and Spain. He recognized the necessity for tunnels and embankments to avoid steep grades and advocated the use of malleable iron instead of cast-iron rails. He founded the Institute of Mechanical Engineers and became its president in 1847. Stephenson died on Aug. 12, 1848, at Tapton House, near Chesterfield. I. B.

**STEREOGRAPHIC PROJECTION.** *See* MAPS AND CHARTS.

**STEREOSCOPIC PHOTOGRAPHY.** *See* PHOTOGRAPHY.

**STEREOTYPING.** *See* PRINTING AND GRAPHIC ARTS (*Printing Platemaking*).

**STERILITY.** *See* REPRODUCTION, HUMAN.

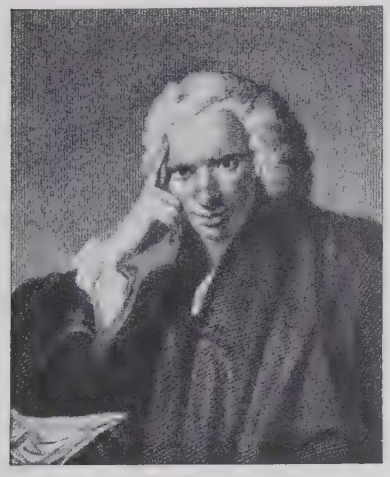
**STERLING,** a city and the county seat of Logan Co., Colo., on the South Platte River, 115 mi. northeast of Denver, at an altitude of 3,947 ft. above sea level. Sterling is an important railroad junction and the main distributing point for a wide agricultural, dairying, and stock-raising district. Manufacturing centers around the large beet-sugar refinery of the Great Western Sugar Company. The valley of the South Platte at this point was first settled in 1872, and the town site was platted in 1881. Incorporated in 1883, the growth of the town as a trading center was rapid, largely owing to the exceptional productivity of the surrounding area. Pop. 1950, 7,534. C. W. D.

**STERLING,** a city in Whiteside Co., in northwestern Illinois, situated on Rock River, 110 mi. west of Chicago. It is served by the Chicago and North Western and the Chicago, Burlington & Quincy railroads. Builders' hardware and steel products constitute the chief manufactures. The surrounding region is agricultural. To the northeast is White Pines Forest State Park. Sterling was incorporated in 1857. Pop. 1950, 12,817.

**STERN, OTTO** [shtɛ′rn; stɜ′rn] (1888- ), German-American physicist, was born in Sohrau, Germany, Feb. 17, 1888. He was educated in Germany, obtaining his Ph.D. degree at Breslau in 1912. He was *privatdozent* at the Technische Hochschule, Zürich, in 1913 and 1914; and at Frankfurt from 1914 to 1921. In 1921 and 1922 he was professor of physics at Rostock, and from 1923 to 1933 he was professor at Hamburg. He came to the United States in 1933 as research professor of physics at the Carnegie Institute of Technology. Stern is most noted for his highly significant measurements of the magnetic properties of individual atoms. In 1921, with Walter Gerlach, he performed the classical experiment on atomic magnetic moments which became one of the experimental foundations of modern quantum theory. In 1933 he refined his experimental technique so that he was able to measure the magnetic moment of atomic nuclei. He was awarded the 1943 Nobel Prize in physics. L. N. R.

**STERNE, LAURENCE** (1713-1768), English novelist, was born at Clonmel, Ireland, Nov. 24, 1713. His father, an improvident army ensign, after dragging his family through various barracks in Ireland, left ten-year-old Laurence at school in Yorkshire, near influential relatives who in 1733 helped him enter Jesus College, Cambridge. The Church was an inevitable career for the great-grandson of an archbishop and nephew of an archdeacon. Ordained priest in 1738, Sterne shortly became vicar of Sutton and prebendary of York Cathedral. In 1741 he married Elizabeth Lumley. Her income increased his security, and their daughter Lydia became his chief joy, but his wife's emotional instability and his own indiscreet flirtations severely strained his marriage. Always frail, he was frequently prostrated by hemorrhages, which began when he was at Cambridge. He quarreled simultaneously with his mother, who pestered him insatiably for money, and with his uncle, the archdeacon. In 1758 his wife became temporarily insane.

During these troubled years Sterne's solace was a group of eccentric companions, the "Demoniacs." Their leader was Hall-Stevenson, and the scene of their mild escapades was his Skelton Castle, with its library of curious and indecent lore. There, especially from Burton and Rabelais, Sterne acquired much of the odd learning which crams his books. Fortunately all his models were not esoteric; they included Montaigne, Shakespeare, Cervantes, Locke, and Swift. Sterne's way of life, his pamphleteering, and his dramatic and unorthodox sermons had already molded his



*LAURENCE STERNE*

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style and brought him a local reputation before he journeyed to London in December 1759, with the first two volumes of *Tristram Shandy*.

The wit, humor, and audacity of this work and of Sterne's conversation captivated London. Dr. Johnson dismissed him as a fad; Horace Walpole denounced him; Bishop Warburton, after befriending him, turned against him; Garrick remained staunch. Within a year Sterne published four more volumes of his novel, then spent 1762-1764 with his family in southern France, vainly seeking health. A year in England, two more volumes of *Tristram Shandy,* and he was back in France and wandering through Italy, still racked with coughing, still determinedly cheerful. His wife and daughter, who had refused to return to England since first landing in France, again let him go home alone. In 1767 he finished the ninth and last volume of *Tristram Shandy*. Now fast dying of consumption, he became sentimentally infatuated with Mrs. Draper (the Eliza of the *Journal* published after his death); but she rejoined her husband in India, and soon thereafter Sterne permanently but amicably separated from his wife. Early in 1768 he hurried to London to publish *A Sentimental Journey,* and there, assured of its success but lonely among friends, he died on March 18.

**Personality and Literary Style.** Sterne's life both helps and hinders understanding his work, most of which is semi-autobiographical. He draws on his travels in France for *A Sentimental Journey,* and is always breaking into *Tristram Shandy* with reminiscence and interjection; in fact, his own personality gives unity to a deceptively chaotic book. But Sterne's self-portrait as Yorick is selective, what he wanted to be and to be thought—sometimes better, often worse than he was. His mercurial temperament, his devil-may-care recklessness he deliberately accentuates; his illness and share of genuine tragedy he ignores or turns into comedy. He once wrote, "The world has imagined, because I wrote *Tristram Shandy,* that I was myself more Shandean than I really ever was." By "Shandean" he meant an attitude of constant attack on melancholy, and on religious and moral austerity; enthusiastic support of joy, sentiment, and the natural goodness of man. Sterne always appeals from the head to the heart, and not all these appeals are mawkish. Sometimes he smirks lewdly; but basically he pleads for tolerance of frailty, and his best comedy is of the highest order, since he understands human nature. Not only is irony tempered with affection; his sentimentality is often ironic self-satire. His wit lies as much in precision of phrase as in ambiguity and innuendo. While his tricks, anticlimaxes, and digressions are frequently tiresome, he is a master of surprise and drama; his writing is so sharply visualized that events described seem to happen in reality.

Of his two masterpieces, *A Sentimental Journey* is slighter, more carefully contrived. Its prose ranks with the most felicitous prose in English. Sterne travels in the character of Yorick, not to see places but to meet people. He delights in subtle distinctions and revealing peculiarities, sketching brilliantly in few strokes; his only full-length portrait is that of his servant, La Fleur. But Sterne's virtuosity requires the larger, less-finished canvas of *Tristram Shandy,* crowded with minor figures such as La Fever, Widow Wadman, Doctor Slop, and Corporal Trim, in their way as entertaining as Walter Shandy and Uncle Toby.

Though his caricature and pathetic comedy influenced such novelists as Dickens, Sterne is inimitable. He seemed outside the main tradition of the novel until James Joyce and others developed the stream-of-consciousness technique, which has changed our perspective and made us more aware of Sterne's brilliant and subtle, if seldom profound, psychological penetration. *See also* SENTIMENTAL JOURNEY, A; TRISTRAM SHANDY.

W. B. C. W.

**STERNE, MAURICE** [stɜ′rn] (1878- ), Russian-American painter, was born July 13, 1878, in Russia. Removing to the United States in 1889, he studied at Cooper Union in 1892 and at the National Academy of Design from 1894 to 1899. By 1903 he was an instructor in etching at the National Academy, and by 1904, he had qualified for its traveling scholarship in Europe. Remaining four years abroad, Sterne toured many art centers and started work as a sculptor. He visited Egypt in 1911 and Burma and Java in 1912, returning to the United States in 1915. During this period, between travels, he held many exhibitions. In 1929 his *Monument to Early Settlers* was unveiled at Worcester, Mass., and four years later he had a one-man show at New York's Museum of Modern Art. In the 1930's Sterne again lived in Europe and later did murals for the United States Department of Justice. These prompted Royal Cortissoz, the critic, to say that Sterne "mixed brain-stuff with his colors," while Thomas Craven has said, ". . . his approach to art is that of one who has the sympathetic and sensitive but penetrating understanding of a great humanist."

J. Me.

**STESICHORUS** [stəsɪ′kɔrəs] (c. 632-553 B.C.), Greek lyric poet, was born at Locri in southern Italy. Living at a time slightly later than Alcman's, he was approximately a contemporary of Alcaeus and Sappho. Although his career is chiefly associated with Himera in Sicily, he probably also spent some years in the Peloponnesos. He is said to have reached his eightieth year.

His real name was Tisias; the nickname Stesichorus (Chorus Marshaler) is derived from his poetic activity. The combined Dorian and Ionian heritage of his adopted home, Himera, enabled him to emancipate Dorian choral song and

make it Panhellenic. This important writer's works, later edited in twenty-six books, have been so poorly preserved that our loss must be regarded as staggering. His poems were chiefly large-scale festival hymns, narrative in character and drawing freely on epic poetry for material. They include *Funeral Games for Pelias, Oresteia, Helen,* and the *Sack of Ilium.* Stesichorus remodeled many of the myths upon which he drew, and gave them a form which influenced Attic tragedy and pictorial art of all kinds. His use of the Daphnis story and his *Rhadine* and *Calyce* establish him as the remote ancestor of the pastoral and the romantic novel. Quintilian justly called him a lyric Homer who bore the weight of epic on his lyre. C. M. D.

**STETHOSCOPE.** *See* LAËNNEC, RENÉ THÉOPHILE HYACINTHE.

**STETTIN.** *See* SZCZECIN OR STETTIN.

**STETTINIUS, EDWARD REILLY, JR.** (1900-1949), American financier and statesman, was born in Chicago, Ill., Oct. 22, 1900. He was educated at Pomfret School and at the University of Virginia. He left college in 1924 to join the General Motors Corporation, of which he was made a vice-president in 1931. He joined the United States Steel Corporation in 1934, becoming chairman of the board in 1938. In 1939 Stettinius was made head of the national War Resources Board. In 1940 he resigned from private business and served for a year as an adviser to the Council of National Defense, then as lend-lease administrator. In 1943 he was appointed Under-Secretary of State and a year later succeeded Cordell Hull as Secretary. As Secretary, he attended the Yalta Conference in February, and headed the American delegation to the San Francisco Conference of the United Nations in April 1945. He resigned as Secretary in June of that year but continued for another year as permanent delegate to the United Nations. He died at Greenwich, Conn., Oct. 31, 1949. C. W. D.

**STEUBEN, BARON FRIEDRICH WILHELM LUDOLF GERHARD AUGUSTIN VON** [styu′bən; shtɔi′bən] (1730-1794), German-American general, was born Nov. 15, 1730, in Magdeburg, Prussia. Tutoring by his father, a Prussian captain, and intermittent schooling at Neisse and under the Jesuits at Breslau prepared Steuben for the career he began as a Prussian lance corporal in 1746. Although further trained in the military classes of Frederick the Great during the Seven Years' War (1756-1763), he was only a captain when discharged in 1763. After leaving Prussia, he served as grand marshal at the court of Prince Hohenzollern-Hechingen, where he was knighted in 1769. However, subsequent financial difficulties, visits to Paris, and meetings with Benjamin Franklin inspired him to volunteer for American service with remuneration contingent upon the winning of independence. Von Steuben sailed for America in 1777, presented himself to Congress, and in February 1778 reported to General George Washington at Valley Forge. When Congress appointed him inspector general that year, with a major general's commission dated May 5, he had already inaugurated unified drill regulations for the Continental Army and expedited its reorganization. At Monmouth and throughout the 1779 and 1780 campaigns, he was Washington's tactical adviser. At West Point he systematized Howe's fortification procedures and light infantry operations. He also commanded the Yorktown forces that received General Charles Cornwallis' first offer of capitulation and, at the war's end, assisted in demobilization.

Von Steuben was discharged from the Army in 1784 and became a naturalized American citizen. Membership on the first Board of Regents of the University of the State of New York, presidency of the Society of the Cincinnati, a gold-hilted sword, special thanks from Congress, and rich but unsalable land grants were among the honors he received. However, not until 1790 did Congress grant him an annual pension to recompense him for brilliantly transforming Washington's ragged armies into effective, well-disciplined troops. He died at Steuben, Oneida Co., N. Y., on Nov. 28, 1794. M. C. C.

**STEUBENVILLE** [styu′bənvɪl], a city in eastern Ohio, the county seat of Jefferson Co., situated on the Ohio River, on the Ohio-West Virginia boundary, about 50 mi. southeast of Canton and 23 mi. north of Wheeling, W. Va. Steubenville is built on a plain surrounded by high hills with rich oil, gas, and clay deposits. Shaft and strip mining of these minerals is a leading activity in the region. The city was the site of Fort Steuben, built during the Revolutionary War and named for Baron Friedrich Wilhelm von Steuben. The community was settled in 1797 and incorporated in 1854. During the Civil War it was an important post on the Underground Railroad. Edwin M. Stanton, Secretary of War under Lincoln, made his home in Steubenville, which developed early in the nineteenth century as an industrial center. The community was one of the first to employ steam for manufacturing purposes. Transportation for the city is furnished by river craft and the Pennsylvania and Wheeling and Lake Erie railroads. Steel production is the predominant industry. Pottery, nitrous products, paper, and wood products are other manufactures. Pop. 1950, 35,872.

**STEVENS, JOHN** (1749-1838), American engineer, was born in New York City in 1749. He studied law and was admitted to the New York bar in 1771. From 1777 to 1782 he was treasurer of New Jersey. However, he is best known for his improvements of the motive power and machinery of steamboats. In order to protect his inventions, he presented a petition which was used as the basis of the first United States patent law in 1790. He applied for some of the earliest patents—for a multitubular boiler and for a method of screw propulsion for steamboats. In 1808 Stevens built the engine for the *Phoenix,* which, as the first ocean-going steamboat, he sailed from New York to Philadelphia. Proposing bridges across the Hudson and East rivers and a tunnel under the Hudson, he was ridiculed as a dreamer. At the request of a joint army and navy board, he wrote with his son Edwin Augustus Stevens (1795-1868) a report on armed steamboats as a means of coastal defense.

Also interested in railroads, Stevens, on Feb. 6, 1815, received the first railroad charter in the United States for a line across New Jersey between the Delaware and Raritan rivers, although it was not until 1830 that he formed the Camden and Amboy Railroad and Transportation Company and not until 1832 that the first train was run. He also bought much land in Hoboken, around the site of the ferry landing, and was active in the development of the city. Stevens died in Hoboken on Mar. 6, 1838. S. M. M.

**STEVENS, ROBERT LIVINGSTON** (1787-1856), American engineer, was born in New York City on Oct. 18, 1787, the second son of John Stevens. He was trained by his father in mathematics and mechanics, proved an exceptionally able student, and at seventeen helped his father build the first twin-screw steamboat. In 1841, Robert Stevens and

his brother, Edwin Augustus Stevens (1795-1868), designed for the United States Government the so-called *Stevens Battery,* an armor-plated vessel capable of withstanding the 64-lb. shot, the heaviest then in use.

The two brothers managed their father's Camden and Amboy Railroad and Transportation Company, which later became part of the Pennsylvania Railroad. In 1830 Robert Stevens went to England to procure equipment for their railroad, and, dissatisfied with the size of the English rails, designed the rail which has since become the universal standard. He also invented the hooked spike that holds the rails in place and made improvements in the current roadbed. His engine, the *John Bull,* made its first short trip on Nov. 12, 1831, although the line was not in operation until 1832. Stevens died on Apr. 20, 1856. *See also* STEVENS INSTITUTE OF TECHNOLOGY. S. M. M.

**STEVENS, THADDEUS** (1792-1868), American lawyer and congressman, was born at Danville, Vt., Apr. 4, 1792. He was graduated from Dartmouth College in 1814, and while teaching in a school at York, Pa., began to read law. He practiced at Gettysburg, Pa., for fifteen years, and became a prominent lawyer. His intense hatred of slavery led him to defend many runaway slaves without charge.

As a leader of the Anti-Masonic Party, Stevens was elected to the Pennsylvania House of Representatives in 1833, and served three terms (1833-1835, 1838-1839, 1841-1842). He won fame for his efforts to extend the free-school system over the entire state. He retired temporarily from politics in 1842 and returned to the practice of law at Lancaster, Pa., but was elected to Congress on the Whig ticket in 1848. He was vigorous in his opposition to the Fugitive Slave Law of 1850. His term ended in 1853, but he was re-elected in 1858 and, as one of the leaders of the Republican radicals, was known for his fierce speeches against slavery and was in favor of protective tariffs. He was prominent in organizing the Republican Party in Pennsylvania.

In 1861, Stevens became chairman of the House Ways and Means Committee, and though he gave President Abraham Lincoln full support in carrying out necessary financial measures during the Civil War, his views on the conduct of the war did not coincide with the President's. He was harsh and vindictive toward the South, and in 1864 spoke of exterminating the "rebels" and recolonizing the South. During Reconstruction, Stevens wanted the South to be under a severe military government, and he has often been held responsible for accentuating reconstruction problems.

Stevens was a leader in the Congressional struggle with President Andrew Johnson, and was chairman of the group that drafted the impeachment, although he was not active in the trial because of ill health. He died in Washington, D. C., on Aug. 11, 1868, after having requested burial in a cemetery in Lancaster, Pa. because it was open to Negroes. R. F.

**STEVENS INSTITUTE OF TECHNOLOGY,** an accredited, nondenominational, privately controlled technological school for men. The main campus covers 30 acres in Hoboken, N. J., and the summer engineering camp occupies a 345-acre tract at Johnsonburg, N. J. The institute, founded under a bequest left by Edwin A. Stevens in 1868, was incorporated in 1870, and first instruction was given the following year. Graduate courses were introduced in 1930, and the Graduate School was formally organized in 1938.

The only degrees offered are the M.E. and the M.S. All freshmen are required to attend the six-week summer camp. In the library are the collection of the Stevens family papers and the Taylor collection on industrial management.

Some dormitory facilities are provided. Fraternity houses provide living accommodations for their members. Scholarships, student loans, and work opportunities are available. Many students earn part or all of their expenses. *For statistics see* COLLEGES AND UNIVERSITIES. J. R. To.

**STEVENSON, ADLAI EWING** (1900- ), American lawyer and political leader, was born in Los Angeles, Calif., Feb. 5, 1900. His grandfather, of the same name (1835-1914), was Vice-President of the United States for the second Cleveland administration. The younger Stevenson attended public schools in Bloomington, Ill., where his family lived, Choate School and Princeton University, from which he graduated in 1922. After a year at Harvard Law School, he worked for the Bloomington Daily *Pantagraph* and then studied law at Northwestern University Law School. He was admitted to the Illinois bar in 1926 and, except for a brief period in Washington as a counsel for government agencies, practiced law in Chicago until Secretary of the Navy Frank Knox brought him to Washington in 1941 as his special assistant. In 1943 he headed a mission to Italy to plan occupation policies. He served as special assistant at the San Francisco Conference on World Organization in 1945 and, later that year, served as United States representative to the Preparatory Commission for the United Nations in London. At the first session of the United Nations General Assembly in 1946, he was senior adviser to the United States delegation and continued as a delegate until after the 1947 session.

In 1948 he was selected as the Democratic candidate for governor of Illinois and was elected by the largest margin in the state's history. As governor, Stevenson succeeded in eliminating much of the waste and political laxity that had existed in the state government, initiated improvements in state welfare and education, and launched an extensive highway reconstruction program. In 1952, in spite of his efforts to discourage a draft for the Presidency, the Democratic Convention nominated Stevenson on the third ballot. Running against the Republican nominee, Dwight D. Eisenhower, Stevenson conducted a vigorous campaign in which he displayed an ability to set forth issues in a stimulating and forthright manner and acquired national standing as a political leader of intellect and integrity. In the Republican landslide which marked the election, Stevenson won only 89 of the 531 electoral votes, although he received 27,312,217 popular votes as against 33,938,825 for General Eisenhower. In 1953 Stevenson made a six-month good-will tour around the world. W. Jo.

**STEVENSON, ROBERT LOUIS BALFOUR** (1850-1894), Scottish author, was born in Edinburgh, Nov. 13, 1850, of a family of eminent engineers. Stevenson, whose early schooling was broken by periods of illness, began to write at an early age. In 1868, following trips to Germany and Italy with his mother, he began to study his father's profession of civil engineering at the University of Edinburgh and in 1871 won the medal of the Scottish Society of Arts for a paper entitled *A New Form of Intermittent Lights for Lighthouses.* In this same year, because of his health, he gave up engineering and began the study of law. He was admitted to the bar in 1875, but never practiced.

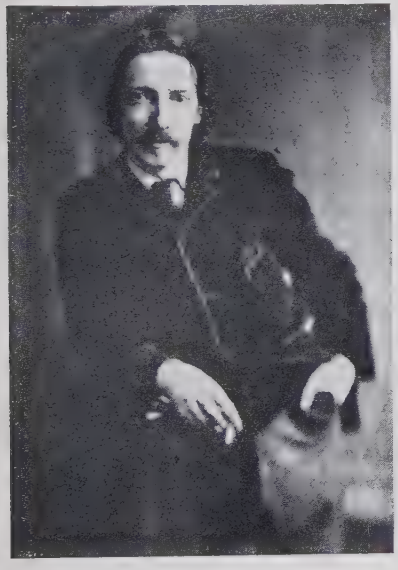
In 1873 Stevenson had met Sidney Colvin and other literary men. He began to contribute essays to magazines and then went on the wanderings in Scotland, France, and Germany which gave him the material for his first books, *An In-*

*land Voyage* (1878) and *Travels with a Donkey* (1879).

Stevenson fell in love with the American Mrs. Osbourne in France in 1876. She and her fourteen-year old son returned to their home in California in 1878, and, hearing of her sickness, Stevenson followed by steerage and immigrant train in 1879. Mrs. Osbourne's divorce enabled them to marry in May 1880, and that autumn they returned to Scotland. His health failing again, he spent the next two winters in Davos, and in the autumn of 1882 moved to the south of France, where he lived until in 1884 his health forced him to return to England. *Virginibus Puerisque* was published in 1881. In 1882 came *Familiar Studies of Men and Books* and in 1883 both *The Silverado Squatters* and the most famous of his boys' books, *Treasure Island,* which had earlier appeared in a magazine as *The Sea-Cook.*

With *Treasure Island,* a story of pirates and buried treasure, Stevenson's popularity began. It was enhanced by *A Child's Garden of Verses* (1885), *The Strange Case of Dr. Jekyll and Mr. Hyde* (1886), his most famous short story, *Kidnapped* (1886), one of his best longer stories, and *The Black Arrow* (1888).

In August 1887, after the death of his father, Stevenson left England and Europe for good. After some time spent at Saranac Lake under the care of a physician, he went to San Francisco and from there sailed to the Marquesas Islands. In Honolulu he finished *The Master of Ballantrae,* which had been begun at Saranac. About Christmas, 1889,



ROBERT LOUIS STEVENSON

Stevenson and his family landed at Samoa for a six-week stay, before going on to Sydney. The last four years of his life he spent in Vailima, on Samoa, where he became known as Tusitala by the natives, in whose affairs he took a great interest. *David Balfour,* a sequel to *Kidnapped,* was published in 1893. *The Ebb Tide* (1894) was the last of his books that he saw through the press. He was writing *The Weir of Hermiston,* which promised to be a more mature work than his earlier stories, when on Dec. 3, 1894, he died of an apopletic stroke and was buried by the natives on a hill overlooking the ocean.

Robert Louis Stevenson was romantic by temperament, in his adventurous life, and in all of his writing. His stories are of buccaneers, warring highlanders, knights and archers, swordplay, kidnappings, and escapes. In his essays he preached facing the bright face of danger, living life to the full, spending health like a spendthrift instead of hoarding it like a miser. Stevenson himself, his restlessness and vivacity accentuated by a tubercular feverishness, was tall, thin, dark-haired, brilliantly dark-eyed, something of a poseur in dress and manners. His personality attracted many who found his romanticism charming and admired the courage he showed through his lifelong ill health. It offended others, like Henry Adams, who visited him in Samoa in 1890 and thought him unclean in person and second-rate in talent.

Through imitating the style of other writers, playing "the sedulous ape," as he described it, Stevenson early attained great skill and dexterity in writing. All of his writing is marked by a surface perfection that is sometimes more noteworthy than its content. Stevenson wrote to entertain. He did not in his fiction attempt character creation or concern himself with social or ethical problems. The ideas he used were simple, often trite. Though he admired the sophisticated George Meredith, he wrote romances of adventure after the manner of Scott, Cooper, and Dumas, and decried the realistic approach adopted by the more serious novelists of the period. In *A Humble Remonstrance* (1884) he stated his belief that narrative is the most important element in fiction and that "the novel, which is a work of art, exists not by its resemblance to life . . . but by its immeasurable difference from life."

While acknowledging their excellence as almost perfectly written adventure tales dealing principally with childhood and youth, critics point accurately to an immaturity in Stevenson's fictional works. The same comparative immaturity is obvious in his optimistic, high-spirited essays, which are rhetorical and didactic, seldom profound. Though *Aes Triplex, Virginibus Puerisque,* and *Pulvis et Umbra* are better known, his delightful *The Lantern Bearers* shows Stevenson at his best as an essayist. J. P. Wo.

**STEVENS POINT,** a city in central Wisconsin, the county seat of Portage Co., on the Wisconsin River, in rolling agricultural country, about 120 mi. northwest of Milwaukee. George Stevens established a trading post with the Potawatomie Indians on the site in 1868. The town was surveyed in 1839 and incorporated in 1858. Stevens Point has the mayor-alderman form of government. The Central State Teachers College is located in Stevens Point, which has transportation facilities furnished by the Green Bay and Western and the Minneapolis, St. Paul & Sault Ste. Marie railroads. Local industries produce fishing tackle, automobiles, furniture, toys, and gas engines. Agricultural products of the region are potatoes, cheese, and butter. Pop. 1950, 16,564.

**STEWART, HOUSE OF.** *See* STUART (STEWART or STEUART), HOUSE OF.

**STEWART, ROBERT.** *See* CASTLEREAGH, ROBERT STEWART, VISCOUNT (MARQUIS OF LONDONDERRY).

**STEYR** or **STEIER** [shtai′r, shtai′ər], a city in north central Austria, in the province of Upper Austria, located at the junction of the Steyr and Enns rivers, about 20 mi. southeast of Linz in a rolling, wooded region. A manufacturing and tourist center, the city is dominated by the tenth-century Steyr Castle. The Stadt-Platz, the main town square, contains a number of seventeenth-century houses, a Renaissance courtyard bounded by three-storied arcades, and the Rathaus, which contains a great council chamber and dates from 1765. The Parish Church was built between 1443 and 1522, and the sacristan's house, south of the church, is noted as the place where Anton Bruckner completed his last compositions between 1886 and 1894. The manufacture of weap-

ons has been an important industry since the twelfth century. Steyr is the center of the Austrian iron industry. Other manufactures besides iron and steel goods include motor vehicles, bicycles, and leather goods. Pop. 1951, 36,818.
E. Ma.

**STIBINE.** *See* ANTIMONY.

**STIBNITE** [stɪ′bnait], antimony trisulphide, $Sb_2S_3$, an ore of antimony. It occurs in prismatic orthorhombic crystals which are vertically striated. The color and streak of stibnite are both lead gray. This mineral occurs in low-temperature hydrothermal veins. It is practically the sole ore of antimony in China, which, in normal times, produces more antimony than all the other countries combined. Iyo Province, Japan, has been the source of beautiful museum specimens of stibnite crystals. K. K. L.

**STICK INSECT,** the common name given to the members of the order Phasmida (sometimes considered a suborder of the Orthoptera). They have biting mouth parts; long antennae; long, slender legs; long, narrow bodies; and

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*A stick insect of the family* Phasmidae, *native to the Trobriand Islands*

they may or may not be winged in the adult stage. Of the more than 2,000 known species, the vast majority occurs in the tropics, where the largest ones, some more than a foot in length, are found. As they rest on plants, they resemble dead twigs, and it is always a surprise to observe them as they begin to move. Some forms are parthenogenetic, no males having yet been discovered. Some are pests of hops; however, other plants may also be heavily attacked. *See also* LEAF INSECT.
C. H. Cu.

**STICKLEBACKS,** small fishes of the family Gasterosteidae, with isolated spines in front of the dorsal fin and a very slender caudal peduncle. Found in fresh and salt waters of temperate regions of the Northern Hemisphere, they are pugnacious and carnivorous, feeding upon small crustaceans and other invertebrates. They seldom exceed 4 in. in length. The three-spined stickleback, *Gasterosteus aculeatus,* is of circumpolar distribution and occurs on the Atlantic coast south of New Jersey. It also gets into fresh water in the Lake Ontario basin. The males build muff-shaped nests of plant materials that are fastened together by mucous threads secreted by their kidneys. After the eggs are deposited within the hollow center of the nest, the male guards them and the young. The brook stickleback, *Encalia inconstans,* is confined to fresh waters of North America. E. C. R.

**STIEGEL, HENRY WILLIAM** [sti′gəl; shti′gəl] (1729-1785), German-American glassmaker, sometimes called "Baron von Stiegel," was born near Cologne, Germany, May 13, 1729. He migrated to Pennsylvania in 1750 and went to work for John Jacob Huber, an ironmaster. Two years later he married his employer's daughter, Elizabeth, and in 1758 purchased Huber's furnace, which he rebuilt and named Elizabeth Furnace in honor of his wife. Stiegel became a prominent land owner and in 1762 founded the town of Manheim in Lancaster County, Pa. He began the construction of a glass factory in 1765, imported skilled workers from Europe, and started to manufacture glass and glass objects. Stiegel's glassware became famous and the individual pieces are now collector's items. However, Stiegel later went bankrupt. He died in Charming Forge, Pa., Jan. 10, 1785. A. W. Gr.

**STIEGLITZ, ALFRED** [sti′glɪts] (1864-1946), American photographer, was born in Hoboken, N. J., Jan. 1, 1864. He studied mechanical engineering, photochemistry, and photography in New York and in Germany until 1890, when he began writing, editing, and exhibiting his photographs. These masterpieces won prizes throughout the world and Stieglitz came to be regarded as the foremost photographic artist and theoretician in the United States. His writings were extensive, many appearing in *Camera Notes,* which he founded and edited from 1897 to 1903, and *Camera World,* which he edited and published from 1903. Stieglitz died on July 14, 1946. B. Su.

**STIGMATA** [stɪ′gmətə] (Gr. *στίγματα,* brand-marks), in a religious sense, the marks (wounds) of the Passion of Christ borne by many ecstatics on hands, feet, side, or brow, with corresponding intense sufferings. These sufferings, when occurring apart from the marks, are called invisible stigmata. The first known stigmatization is that of St. Francis of Assisi. In 1894, Imbert listed 321 stigmatics, including 62 saints or blessed. The fact of stigmatization is not disputed. Its supernatural character in certain cases is maintained by the Roman Catholic Church. The possibility of the phenomenon's being produced by natural causes is disputed.
N. J. T.

**STILICHO, FLAVIUS** [stɪ′lɪko] (c. 359-408), Roman general, was born about A.D. 359. He was a Vandal who entered the Roman army at an early age. Rising to a high military post under Emperor Theodosius, he was made Roman ambassador to Persia in 384. When Theodosius died in 395, he named Stilicho as the guardian of the young prince Honorius, who was to serve as emperor of the West. It was Stilicho who drove Alaric and the Visigoths from Greece in 396 and who defeated them again in 402 and 403 when they invaded Italy. Other triumphs were gained by Stilicho over the Ostrogoths in 405; at an earlier date he was successful in quelling a Moorish revolt in Africa. Honorius and Stilicho ultimately quarreled over the policy toward the Visigoths. Stilicho had hired them to campaign against the Eastern emperor, Arcadius, because this would keep them out of Italy and also weaken Arcadius. When Honorius accused him of treason, Stilicho might have initiated a revolt, but he refused. He was beheaded at Ravenna, Italy, Aug. 23, 408, by order of Honorius. T. B. J.

**STILL, WILLIAM GRANT** (1895- ), American Negro composer, was born at Woodville, Miss., May 11, 1895. A graduate of Oberlin Conservatory, he was twice awarded a Guggenheim Fellowship for creative work. He has used

the Negroid elements of jazz in developing his style, especially in *Lenox Avenue, A Deserted Plantation, Ebony Chronicle,* and the *Afro-American Symphony,* all works for symphony orchestra. Other works include the ballet *La Guiablesse,* Symphony in G Minor, and *Kaintuck,* for piano and orchestra. D. L. E.

**STILL LIFE,** that classification of painting in which inanimate objects furnish the principal subject matter, though they may be associated with persons or animals. Flowers, vegetables, fruit, meat, dead game, household utensils and *objets d'art* are the subjects most frequently used. Still life appeals to the observer in two ways: through association or experience with the objects in real life, and through purely pictorial or formal qualities. An emphasis on association is prominent in Dutch and Flemish work of the seventeenth century and continues generally until the late nineteenth century, when it is largely abandoned in favor of a greater interest in color, form, and design, without great regard for natural appearance.

Still life, as a separate art form, assumed importance in those periods in which its particular attractions were strong enough to inspire artists and furnish them a market for their work. Although examples are known from Hellenistic and Roman times, the modern development began with the Renaissance. The greatly expanded interest in the world and its contents, a familiar characteristic of that period, eventually led artists to an all-embracing desire to paint the objects and scenes of daily experience, and to an increased capacity for representing them. An interest in objects as such was particularly characteristic of the art of northern Europe, and by the early sixteenth century it had, at times, elevated them to a position of almost major importance in figure painting, especially portraiture. The seventeenth century, however, first saw the production of unmixed still life on a large scale. The schools of Holland and Flanders were especially noteworthy, producing such masters as Jan Weenix, Frans Snyders, Jan de Heem, and Willem Kalf, who, in a finely detailed technique, reflected a native delight in the materials of ordinary existence. From this time on, the taste of the growing middle class maintained a steady market for pictures of this type, and some of the pictures reached a level of extraordinary excellence, as in the work of Jean-Baptiste Siméon Chardin (1699-1779), who combined associative pleasure with exquisite formal harmony.

The advent of the progressive modernism of the late nineteenth century produced a greater concern for matters of style and form in painting. One result of this tendency was that still life in the hands of Paul Cézanne, and later on, the Cubists, became a complex study of line, color, shape, and volume in which natural objects as a pleasing factor in ordinary experience largely disappeared. J. C. S.

**STILLWATER,** a city in southeastern Minnesota, the county seat of Washington Co., situated on the St. Croix River, on the Wisconsin border, 16 mi. northeast of St. Paul, in a fertile area of dairying and diversified farming. Founded about 1839, Stillwater was made the county seat in 1840; it was incorporated as a town in 1844 and as a city in 1854. Stillwater's government is the mayor-council-manic type. About the middle of the nineteenth century Stillwater was a bustling, "wide open" logging town. A striking geologic feature is the exposed layer of Jordan sandstone that lies along the river at Stillwater. The Minnesota State Prison is in the city. Transportation is afforded by river craft and the Chicago and North Western, the Northern Pacific, and the Chicago, Milwaukee, St. Paul and Pacific railroads. Lumber, clothing, men's shoes, binding twine, flour, road machinery, and tractors are among the products produced by local industries. Pop. 1950, 7,674.

**STILLWATER,** a city in north central Oklahoma, the county seat of Payne Co., located 75 mi. northeast of Oklahoma City. It is served by the Atchison, Topeka and Santa Fe Railroad. The city is an important distribution point for livestock, dairy products, poultry and small grains. The little industry that exists in Stillwater is confined to the processing of farm products. Stillwater is the seat of Oklahoma Agricultural and Mechanical College. The city was founded by settlers from Kansas in 1889. Pop. 1950, 20,238.

**STILT,** any one of several wading birds in the genera *Himantopus* and *Cladorhynchus,* allied to the avocets, which are found in temperate and tropical regions throughout most of the world. They are characterized by having extravagantly long legs, usually colored red, and their plumage is various combinations of black, white, gray, and rufous. Stilts inhabit sloughs and lagoons of fresh or brackish water, where there is abundance of aquatic vegetation, and feed upon minute forms of animal life. They are famous for the extraordinary vocal demonstrations with which they express solicitude for their eggs or young. The American or black-winged stilt, *Himantopus himantopus mexicanus,* which measures about 15 in., is a common species in the western United States and also appears in the Gulf States. H. G. De.

**STILWELL, JOSEPH WARREN** (1883-1946), American army officer, was born in Palatka, Fla., Mar. 19, 1883. He was graduated from West Point in 1904, and served with the American forces in France during World War I. After the war, he spent several years with American units in China. From 1935-1939 he served as military attache at Peiping, and in 1942 he returned to China, with the rank of lieutenant general and was placed in command of the 5th and 6th Chinese armies in Burma. Later that year Stilwell also received command of all United States forces in the China-India-Burma theatre of war. His outnumbered, inadequate troops were routed in Burma and forced to retreat; two years later Stilwell publicly criticized the British Admiral Lord Louis Mountbatten for failing to launch a full-scale offensive in Burma. Stilwell's uncompromising directness and his desire for efficiency led to his serious disagreements with Chiang Kai-shek; he was recalled to the United States in November 1944 and made commander, as a full general, of the United States Army Ground Forces. He was given command of the 10th army in the Pacific theatre of war in June 1945, but in September, after the war had ended, he was again assigned to the United States. He died in San Francisco, Calif., Oct. 12, 1946. In 1948 Stilwell's diaries and letters were published as *The Stilwell Papers.* R. W. Cr.

**STIMSON, HENRY LEWIS** (1867-1950), American statesman, was born in New York, N. Y., on Sept. 21, 1867. After attending Phillips Andover Academy, he studied at Yale, where he graduated in 1888. He was then graduated from Harvard Law School in 1890 and was admitted to the New York bar in 1891. Stimson practiced law privately in New York City until 1906, at which time he was appointed United States Attorney for the Southern District of New York by President Theodore Roosevelt. Defeated as Republican nominee for the governorship of New York in 1910, he was made secretary of war in 1911 by President William

H. Taft. Not in government service during President Woodrow Wilson's administration, Stimson helped Governor Alfred E. Smith reform the New York State Constitution in 1915. During World War I, he served as a colonel of field artillery in France. In 1927, he was appointed by President Calvin Coolidge to arbitrate a dispute concerning the presidency of Nicaragua.

From 1927 to 1929, Stimson was governor general of the Philippines, and in 1929 he became secretary of state under President Herbert Hoover, where he gained a reputation as

*HENRY LEWIS STIMSON*

CULVER SERVICE

an interventionist. He was chairman of the American delegation to the London Naval Conference in 1930, and after Japan invaded Manchuria in 1931 he fathered the "Stimson doctrine" of nonrecognition of territories and agreements acquired by acts of aggression. He was a strong advocate of the Kellogg Pact (1932), which outlawed war, and in the same year was in charge of the American delegation to the Geneva Disarmament Conference. Stimson believed in increasing income taxes for the wealthy and in universal military training; as secretary of state, he was the first in United States history to have a military aide. With the election of President Franklin D. Roosevelt in 1933, he resumed his private law practice, but supported Roosevelt's foreign policies. In 1937, he was elected president of the New York City Association of the Bar. Stimson advocated the discontinuance of supplies for Japan and was a supporter of Cordell Hull's proposed neutrality bill prior to World War II. At the outbreak of World War II (1939), Stimson proposed compulsory military training and a foreign policy whereby Great Britain could obtain American supplies and munitions. He was secretary of war under President Roosevelt from July 1940, to April 1945, when he retired. Stimson wrote *American Policy in Nicaragua* (1927), among other books, and was co-author of *On Active Service in Peace and War* (1948). He died in New York, Oct. 20, 1950. W. E. A.

**STING RAYS,** common name of the Dasyatidae, a family of rays which resemble skates. The whiplike tail is armed with a long spine or sting on the upper side. This sting, which may be up to 15 in. long in the larger species, is saw-toothed. It is used both as a defensive and offensive weapon. At times the ray circles its prey and, by constantly lashing its tail, strikes it with the sting until it is cut to pieces. Men are sometimes attacked and a surgical operation is occasionally required to remove the broken off spine. It causes horrible pain and in a few cases even death. Ancient writers long suspected and it is now proven that a poison is present. The venom is secreted by cells of glandular tissue which line a narrow groove on either side of the spine. Sting rays are found in most warm seas and enter fresh water. The larger ones may be 6 ft. across the disk and weigh about 60 lb. The northern sting ray, *Dasyatis centrura,* is found along the Atlantic coast from Maine to North Carolina and may reach a length of 12 ft. E. C. R.

**STINKBUG,** the common name given to any member of the family Pentatomidae, of the order Hemiptera. The majority are subtriangular or shield-shaped, being widest just behind the head. On their abdomen there are scent glands that give off an odor that is offensive to most animals. The family contains both predaceous and herbivorous forms, including some that will both suck the juices of plants or feed on other insects. The harlequin cabbage bug, *Murgantia histrionica,* is a pest of cruciferous plants. One of the most interesting of the predaceous species is the friendly perillus, *Perillus occulatus,* which feeds upon potato beetle

*A GREEN AND ORANGE STINKBUG OF THE FAMILY PENTATOMIDAE, AN INSECT WHICH EMITS A DISAGREEABLE ODOR*

COURTESY OF THE AMERICAN MUSEUM OF NATURAL HISTORY

larvae and has at times become so abundant as to render spraying unnecessary. Some of the tropical stinkbugs are an inch long and beautifully colored. C. H. Cu.

**STINKHORN,** a fungus, *Ithyphallus impudicus,* known for its putrid odor. It is found in open woods, in fields, and on lawns in late summer and early autumn. It grows about 3 to 5 in. tall and has a stem about 1 in. in diameter. It is not surmounted by a gilled cap, as the true mushroom is, but by a pitted, darkened cap in which the spores develop. The cap is covered by a mucouslike substance having a repulsive odor. Flies attracted by this penetrating smell carry the spores to other locations. J. C. Wis.

**STINKWOOD,** a large South African tree, *Ocotea bullata,* of the laurel family. Its hard, durable, ill-smelling wood is valued for shipbuilding. The name is sometimes applied to several other trees having malodorous wood, including *Nyssa sylvatica,* of the tupelo family, native to eastern North America, and stinkwood hackberry, *Celtis kraussiana,* a South African of the elm family, both of which produce useful timber; also Carolina buckthorn, *Rhamnus caroliniana,* an ornamental of the buckthorn family found in southeastern North America. J. C. Wis.

**STIRLING** [stɜ′rlɪŋ], a shire and its administrative burgh, located in central Scotland.

**The City.** The city of Stirling, situated on the Forth River, is a port and rail center, about 25 mi. northeast of Glasgow. The Romans had a station on the site, but the origin of the castle is unknown. Stirling's first known charter was granted by Alexander II in 1226, and the last governing charter was given by Charles I in 1641. For over five hundred years a royal residence and capital, the castle was the deathplace of Alexander I in 1124 and that of William the Lion in 1214, and it was the birthplace of James II in 1430, probably that of James IV in 1473, and that of James V in 1512. Monarchs crowned at the parish church were Mary Queen of Scots and her son, James VI. The castle is used as a barracks. However, the Chapel Royal is preserved, and on the walls in 1946 were uncovered the insignia of James VI, painted between 1600 and 1610. A staircase leads to the Douglas Room, kept as a museum, where James II stabbed Douglas in 1452. Stirling surrendered to the English in 1296, but Wallace recaptured it in 1297. Carpet weaving, wool spinning, cattle marketing, and the manufacture of rubber, confectionery, and farm implements comprise the principal industries. Pop. 1952, 26,824.

**The County.** Stirling County, known for its coal mines, has an area of 451 sq. mi. It is bounded by Perthshire on the north, Clackmannanshire and the Firth of Forth on the east, West Lothian and Lanarkshire on the south, Loch Lomond and Dumbartonshire on the west. It is a county of contrasts, from the wild highlands of the Fintry Hills, Gargunnock and Kilsyth Hills, the highest peak of which is Ben Lomond, with an elevation of 3,193 ft., to the lowlands with their well-developed coal measures. The eastern part of the county is flat and well cultivated. Coal, iron, limestone, and sandstone are abundant. Iron manufactures are the staple industry, and there are woolen and cotton mills, large chemical works, and distilleries. Falkirk, Kilsyth, and Grangemouth are important centers, in addition to the county town, and four rivers—the Forth, Avon, Endrick, and Carron—water the region. Stirlingshire unites with Clackmannanshire to return two members to Parliament. Pop. 1952, 188,239. A. W.

**STOAT,** the large weasel, *Mustela erminea,* of Europe. When in the summer pelage of brown, the animal is referred to as a stoat. On changing to white in winter, the animal becomes an ermine. The term "stoat" should be considered synonymous with weasel. *See also* WEASEL. W. J. Ha.

**STOCK, FREDERICK AUGUST** [stɒ'k] (1872-1942), German-American orchestral conductor, was born in Jülich, Germany, Nov. 11, 1872. He attended the Cologne Conservatory and from 1891 to 1895 was a violinist in the Cologne orchestra; in 1895 he became leader of the viola section in the Thomas Orchestra of Chicago and was appointed assistant conductor of this organization in 1901. In 1905, following Thomas' death, he became permanent conductor and retained this position until his death on Oct. 20, 1942, in Chicago. Stock was noted for his interpretation of modern German music and for the general excellence of his orchestra. He composed a symphony and other works but is distinguished in this field only for his technical mastery. E. L. F.

**STOCK.** *See* BANKING, INVESTMENT.

**STOCK,** a genus, *Mathiola,* of downy herbs or subshrubs of the mustard family, having oblong or narrow leaves and terminal clusters of mostly purplish flowers. There are about 500 species, mostly native to the Old World and Australia. Common stock, *M. incana,* native to the Mediterranean region, is an erect, branching, biennial or perennial herb, growing as high as 2½ ft.; it is cultivated ornamentally in many varietal forms for its autumn bloom. Ten-weeks stock, *M. i.* var. *annua,* a summer-blooming annual, is extensively grown for the florist trade. Grecian stock, *M. bicornis,* is valued for the fragrance of its small, purplish flowers, which open in the evening. J. C. Wis.

**STOCK, VIRGINIA,** *Malcomia maritima,* a plant of the mustard family, closely related to stock. It is an attractive hardy annual from the Mediterranean region, growing about 1 ft. high. The lilac, red, or white flowers are veined at the base of the petals. Plants will bloom all summer if successional sowings are made. J. C. Wis.

**STOCKBROKER.** *See* BANKING, INVESTMENT (*Organized Security Exchanges*); BANKING INSTITUTIONS.

**STOCK CONTROLS.** *See* INDUSTRIAL TECHNIQUES (*Industrial Controls*); MARKETING AND MERCHANDISING (*Merchandising*).

**STOCK EXCHANGE.** *See* BANKING, INVESTMENT; BANKING INSTITUTIONS.

**STOCKHOLM** [stɒ'khom; stɔ'khɔ'lm], the capital of Sweden and of the county, or *län,* of Stockholm, located in southeastern Sweden on the Baltic Sea.

**The City.** The largest city, port, and manufacturing center in Sweden, Stockholm is situated at 59° 20′ N. lat. and 18° 03′ E. long. at the outlet of Lake Mälar where it flows into the Baltic Sea. The surrounding country is broken into great rock blocks separated by two systems of geologic faults, which have cliffs on their margins and water-filled channels between the blocks. Today these channels serve as the port of Stockholm, notably the steamship port on Lilla Värtan, while the cliffs form considerable eminences within the city, such as the 150-ft. escarpment of Södermalm on the southern mainland. A glacial esker, a long, low, sinuous ridge, was deposited in ancient times upon this rock base and became an early route of communications, since it reached the shores at Saltsjön, the narrowest point, where crossing was possible. The region of Stockholm is heavily forested with many coniferous growths interspersed with extensive rock exposures. Stockholm's annual temperature ranges from 29° F. in January to 62° F. in July. The average annual rainfall is 20.7 in.

*Industries and Transportation.* Stockholm is the largest manufacturing city of Sweden and its largest importer, although it is exceeded in exports by Göteborg. Industries include mechanical and electrical machine works, shipyards, sawmills, rubber factories, motion pictures, and the manufacture of metals, paper, textiles, porcelain, and ironware. The city is well served by railways extending to all parts of Sweden and connecting via Denmark with the Continent and via Oslo with Norway. Shipping lines reach to Finland and the entire Baltic as well as many world ports. Airlines lead to all of Europe and South and North America. Pop. 1952, 761,727.

**Buildings and Educational Institutions.** Stockholm is a modern city and an outstanding example of carefully studied town planning, with many co-operative housing developments, broad avenues, and numerous parks. It is the seat of the Nobel Institute, and the annual Nobel Prize awards are made in Stockholm's Concert Hall.

Notable buildings in Stockholm form two groups: those built in the monumental style of previous centuries, and those erected during the rebirth of Swedish architecture in the twentieth century. The older buildings are confined

mostly to the islands of Staden and Riddarholmen, bounded by the Saltsjön to the east, Lake Mälar to the west, and the Söderström and Norrström, which connect these bodies of water. Here are located the Royal Palace (1754); St. Nicholas Cathedral, built in the mid-thirteenth century; the Riddarholmskyrkan, the Swedish Pantheon, which is the tomb of many Swedish kings and nobles; and the Börs or Exchange and the Arvfurstens palats, built in the 1770's and 1780's. The newer structures include the Royal Opera House (1898); the Swedish Parliament Building (1905); the Royal Dramatic Theatre (1908); the Stadshuset or Town Hall, Stockholm's most famous landmark, built by Ragnar Östberg in 1911; several new hospitals; the Stadium, built for the 1912 Olympic Games; and many modern office buildings and two modern churches, all contributing to Stockholm's contemporary look. To the east of Staden is the island of Djurgrden, which contains a natural park and an open-air museum called Skansen. Many museums and large sports centers can be found in Stockholm. Modern suburbs to the west of the city represent the newest ventures in city planning. The College of Science and Engineering, or Tekniska Högskolan (1914-1929), is the oldest institution of higher education in Stockholm. It was founded as The Technological Institute in 1825. Others include the Karolinska Institutet (1810); Stockholm University (1877); the Stockholm School of Economics (1909); and several other institutions.

*History.* Stockholm's founding date is given as 1252, but a fishing village was located on the site previous to that time. The city's development began with the building of a strong castle on the Norrström waterfront by Birger Jarl in 1252, to guard Lake Mälar against pirate raids, and shortly thereafter when the king moved his headquarters from Uppsala to Stockholm, giving the town political and commercial importance. Business in Stockholm at that time was in the hands of German merchants from Lübeck, who held a privileged position until 1471. During the Middle Ages, Stockholm remained the *Staden mellan broarna,* the town between the bridges, since it was confined to the islands of Staden and Riddarholmen, which are separated from the north shore, Norrmalm, and the south shore, Söderlmalm, by streams. With the advent of the Vasa Dynasty in 1523, the city became the center of government and the treasure of the realm was moved to Stockholm, which gained importance as the country grew, particularly under Gustavus Adolphus. During the reign of John III (1568-1592) the monumental style and rectangular street pattern of the Italian Renaissance were inaugurated to replace the Gothic architecture of the older city. The old castle of the Three Crowns was destroyed by fire in 1697 and replaced in 1754 by the present Renaissance structure. The power of Sweden diminished during the late seventeenth century and slowed its progress. By 1850 the modern era had begun in Sweden, and by 1900 the city grew from 93,000 to 300,000. Stockholm assumed industrial importance early in the nineteenth century.

**The County.** The rural district, county, or *län* of Stockholm includes a series of lakes and bays, which penetrate the interior of central Sweden, and covers an area of 3,041 sq. mi., of which 55 mi. are occupied by the capital, which is administered separately. Many of the most important Swedish industries are located in the area. Lake Mälar and the canal system provide inexpensive transportation for the mineral resources of the interior. Historically, the region is a center of political and social life, having within it many of the famous houses of the nobility. Pop. 1952, 371,598, excluding the city proper.

**STOCKHOLM BLOOD BATH** (Nov. 8-9, 1520), a massacre of Swedish nobles and patriots by Christian II of Denmark. Christian had invaded Sweden in 1520 to put down a Swedish revolt and regain the throne. The widow of Sten Sture the Younger, Christina Gyllenstierna, led the defense of Stockholm until further resistance was useless. After Christian promised amnesty to the Swedish leaders, the gates of the city were opened and Christian entered, eventually to be crowned king of Sweden. In the midst of the coronation celebration the King had many of the former rebels seized. Eighty-two were executed the first day and others later; their bodies were burned. The bodies of Sten Sture the Younger and his infant son were exhumed and also burned. Although the King assumed responsibility for the massacre, Gustav Trolle, the Archbishop of Uppsala, and Didrik Slaghaek were guilty of urging him to the act. When Christian left Stockholm in December 1520, he took with him several hostages. The massacre impelled the Swedes to revolt and eventually was the cause of the dissolution of the Union of Kalmar, binding Sweden, Norway, and Denmark. It also gained for Christian the epithet "the Cruel."

R. E. L.

**STOCKPILING.** *See* Industrial Production (*Raw Materials and Accessory Resources*).

**STOCKPORT,** a municipal, county, and parliamentary borough, partly in Lancashire, and partly in Cheshire, England, 160 mi. northwest of London, where the Tame and Goyt rivers join to form the Mersey. Situated in a coal mining district, it is an important industrial and railroad center. It was once a Roman military station. Stockport, enfranchised in 1832 and incorporated in 1835, was made a county borough in 1888. Industries include cotton bleaching, dyeing, and weaving and the manufacture of felt hats, motors, machine and electrical goods, and food products. The town returns two members to Parliament. Pop. 1952, 141,000.

A. W.

**STOCK SAVINGS BANKS.** *See* Banking Institutions.

**STOCKTON, FRANCIS RICHARD** (1834-1902), American novelist and short-story writer, was born Apr. 5, 1834, in Philadelphia. His family intended him for a career in medicine, but in 1852 he became a wood engraver, demonstrating his success by inventing a double graver in 1866. In 1867 he began contributing to the *Riverside Magazine for Young People,* and his stories were later collected in *Ting-a-Ling* (1870). With this encouragement, Stockton finally abandoned art for journalism and during 1872 and 1873 was associated with the Philadelphia *Post, Scribner's Monthly,* and *Hearth and Home.* His longest employment was as assistant editor of *St. Nicholas* from 1873 to 1881 under Mary Mapes Dodge, but after eight years his success with fiction enabled him to retire from journalism. He died in Washington, D. C., on Apr. 20, 1902.

Stockton is remembered primarily for a single short story, "The Lady or the Tiger" (1884), which at the time of its publication created a popular sensation; its novel conclusion, leaving a choice of endings to the reader, assures it a lasting, if minor, place in literature. Stockton's other short stories, filling twelve volumes, have been forgotten, but of his novels at least two are minor classics of humor: *Rudder Grange* (1879), a burlesque account of an expedition in a houseboat; and *The Casting Away of Mrs. Lecks and Mrs. Aleshine* (1886), a farcical story of adventures following a

shipwreck. A great wit and a born story-teller, Stockton was particularly skillful in inventing a ridiculous or grotesque situation and spinning a whimsical tale around it; he was a master of the implausible. W. P. R.

**STOCKTON,** a port city and the county seat of San Joaquin Co., in western California, situated at the head of the tidewater on the San Joaquin River, 49 mi. south of Sacramento. With the completion of Stockton's 88-mi. deep-water channel to San Francisco Bay in 1933, the city became the state's major inland port. Along the harbor are facilities for ocean-going vessels, grain elevators and conveyors, and warehouses. Much of the city's industry is dependent on the livestock and varied produce of the fertile San Joaquin Valley, whose crops include wine grapes, nuts, sweet cherries, asparagus, celery, and tomatoes.

A community was founded on the city's site in 1844. Because of its location on navigable waters for seagoing vessels, Stockton became an important supply point for the Mother Lode mining area, which opened up in the vicinity after 1848. In 1850 when California became a state, Stockton was incorporated and made the county seat. It continued as the trade center not only for the mine district, but also for the large farm population and lumber interests which moved into the valley. Stockton has the city-manager form of government. Located in the city are the College of the Pacific and Stockton Junior College. Sites of interest include the Civic Memorial Auditorium, the county court house, the Haggin Memorial Galleries, and the San Joaquin Pioneer Historical Museum.

In addition to the ocean steamers, the Atchison, Topeka and Santa Fe, the Southern Pacific, the Central California Traction, the Stockton Terminal and Eastern, the Tidewater Southern, and the Western Pacific railroads and the United Air Lines provide transportation. The city's chief industries produce wine, evaporated milk, processed foods, tools and dies, wooden crates and containers, farm implements, and feeds. There are large wholesale houses, shipyards, canneries, and grain elevators. Pop. 1950, 70,853. S. D. M.

**STOCKTON-ON-TEES,** a municipal and parliamentary borough and port in Durham, England, on the Tees River, 5 mi. from its mouth on the North Sea and 236 mi. northwest of London. Situated in a coal and iron region, it is an important port and industrial and farm-market town. Stockton grew up around the manor of the bishops of Durham, to whom the town belonged. The borough's records date back to 1283. In the fifteenth century it was held by a bishop's bailiff; in 1652 the castle was dismantled; and during Oliver Cromwell's time a representative in Parliament was allowed. The discovery of coal broke the hold of the barons and bishops over the district. In September 1825, service was inaugurated on the first railroad passenger train from Stockton to Darlington. The chief industrial establishments are shipbuilding yards, iron foundries, boiler works, and agricultural markets. Pop. 1952, 73,820. A. W.

**STOICISM** [sto′ɪsɪzəm]. Founded by Zeno of Citium a little before 300 B.C. in Athens, Stoicism, along with Epicureanism, ushered in the new Hellenistic age in philosophy, and it was destined to become the most influential school until supplanted by Neo-Platonism, the final formation of Greek philosophy in the third century of the Christian Era.

After Zeno's suicide (c. 260 B.C.) Cleanthes, the poet, presided over the school from 264 to 232 but he was not able to answer the opponents of Stoicism and to advance his cause. Chrysippus, succeeding him from 232 to 206, reorganized and reinvigorated the movement.

Our information concerning the next two centuries is far from complete. Panaetius of Rhodes (c. 180-110 B.C.) organized Stoicism in Rome, and Posidonius (c. 130-c. 50 B.C.), emphasizing religious speculation, seems to have influenced Philo of Alexandria. The works of Cicero (106-43 B.C.), who was not a Stoic, today furnish a most important source of information on the Stoic theories; and still extant are the works of the great Stoics, Epictetus (A.D. 50-130) and Marcus Aurelius (A.D. 121-180).

The Stoics divided philosophy into three areas: logic, physics, and ethics. Under the heading of logic they made a minute investigation of grammar, but their more fundamental concern was to defend the possibility of truth. Rejecting the sophistical conclusions of pre-Socratic philosophy, and yet not admitting the supersensuous realities of Plato, they thought that another attempt should be made to base truth on sense experience. This attempt requires the existence in the mind of an impression infallibly distinguishable from every false impression, a mental image that attests its own accuracy—an assumption constantly attacked by the Academicians and Skeptics.

The Stoic epistemology was dictated by the Stoic materialistic physics, which held that everything real is a body occupying space, and that, since qualities are real, they, too, are bodies. From this it follows that two bodies can occupy the same space. Obviously, then, bodies are not aggregates of impenetrable atoms moved by impact; rather, as Heraclitus suggested, the world is a dynamic continuum. According to a biological analogy, which was proposed, the particular things of the world are governed in their emergence and development by the inherent power of seeds—sparks, as it were—of the divine reason.

The underlying substance of the world, this divine reason, is an intelligent fire that directs all events. Nothing occurs by chance; everything is governed by Fate. Accordingly, in the religious practice of divination, while the entrails of the victim are not the cause of tomorrow's victory, their condition is consonant only with a world in which this army will be victorious tomorrow. By Fate, universal history goes its determined way: a gradual increase of fire will entirely consume the present order, and a new world will be born to run its course as an exact duplicate of all previous worlds.

Fatalism, however, is not destructive of morality, either theoretically or practically. Theoretically, morality is based not on an uncaused free will, but on voluntary action. A man is responsible for the act he wills. Whether or not he could have willed differently is an idle question. The Stoics exemplified morality in their conduct, and, as time went on, they emphasized it more and more in their writings. The *summum bonum,* according to the Stoics, is rational action, a life according to nature, not bestial nature as in Cynicism, but a life of virtue; to desire the impossible is irrational; and, therefore, we should concern ourselves only with what is in our power—not wealth, pleasure, or reputation, but our inward reaction to the circumstances of life. G. H. Cl.

**STOKE-ON-TRENT,** a city in Staffordshire, England, a county and parliamentary borough, and a railroad center on the Trent River, about 30 mi. south of Manchester and 135 mi. northwest of London, in the famous pottery district known as the Potteries. Stoke-on-Trent was municipally federated with Hanley, Burslem, Longton, Fenton, and Tunstall in 1910, and in 1925 the merged communities were made a city. Stoke was first incorporated in 1874, but

Hanley is mentioned in the Domesday Book. Arnold Bennett, who was born near Hanley, made the "Five Towns" as he called the communities, known over the world through his novels. Josiah Wedgwood, Josiah Spode, Herbert Minton, and W. J. Copeland are names famed in connection with the local pottery industry. The North Staffordshire Technical College has the Solon Library on ceramics, one of the finest in the world. The coal mines and coarse clay pits in the region furnish the basis for the famed potteries. The finer clays used are imported. In addition to porcelain and earthenware, manufactures are aluminum, brick, tile, sanitary ware, electrical porcelain fittings, and tires. The city returns three members to Parliament. Pop. 1952, 272,300. A. W.

**STOKES, SIR GEORGE GABRIEL** (1819-1903), British mathematician and physicist, was born Aug. 13, 1819, in Skreen, County Sligo, Ireland. He entered Pembroke College, Cambridge, and became a fellow in 1841. He remained at Cambridge all his life, being appointed Lucasian Professor of Mathematics in 1849. Two papers by Stokes, dated 1845 and 1850, presented the theory of motion through viscous fluids. He formulated the classic equation for the terminal or steady velocity of a small sphere, such as a raindrop, falling in a viscous medium, such as air. By the year 1849, Stokes had also published papers discussing Newton's rings and the diffraction, interference, and polarization of light. In 1852 Stokes established the fact that the wave length of fluorescent light is always longer than that of the radiation being absorbed by the fluorescing material. He himself utilized the word "fluorescence" because of his observations of the phenomenon in fluorite.

Among Stokes's contributions to science are studies relating to convergence in infinite series, a theorem in vector analysis that bears his name. He also discovered that a reflected ray of light suffers a change of phase of one-half wave length.

Stokes was secretary to the Royal Society from 1854 to 1885 and served as its president for the five-year period commencing in 1885. From 1887 to 1891 he was a representative of Cambridge University in the House of Commons. He became a baronet in 1889. He also received many scientific honors. The stoke, a unit of viscosity, is named for him. Stokes died at Cambridge on Feb. 1, 1903. I. B.

**STOKOWSKI, LEOPOLD** [stɔkɔ'fski] (1882- ), English-American orchestral conductor, was born in London, Apr. 18, 1882, of a Polish father and an Irish mother. After studying composition and organ in London, he became organist and choirmaster at St. Bartholomew's in New York, and from 1909 to 1912 he was conductor of the Cincinnati Symphony Orchestra. From 1912 to 1936 he conducted the Philadelphia Orchestra, which in his hands became one of the great orchestras of the world. Since 1936 he has conducted such orchestras as the NBC Symphony Orchestra, the New York City Symphony, the Hollywood Bowl Symphony, and the New York Philharmonic. He has also appeared in several motion pictures. W. Li.

**STOMACH,** a hollow, muscular, and secretory digestive organ, connected with the esophagus at one end, and with the duodenum at the other. It forms the most dilated portion of the alimentary tract and is situated in the upper left part of the abdomen.

**Anatomy.** The size, shape, and position of the stomach show considerable variations, depending on body-build, posture, and tonus. The normal stomach is often J-shaped and has a capacity of from 1,000 to 1,500 cc. The upper outline is concave and is known as the lesser curvature; the lower outline is convex, about three times longer than the lesser curvature, and is known as the greater curvature. The stomach is usually divided into three parts: pars cardiaca, or fundus; pars media, or the body; and pars pylorica, or antrum. The cardiac sphincter is located at the juncture of the stomach and the esophagus; the pyloric sphincter guards the entrance to the duodenum. The entrance to the stomach is kept open by a small air bubble. The walls consist of four coats.

The innermost coat of the stomach is a mucous membrane. It contains numerous glands, of which the fundic glands secrete pepsinogen, renninogen, and hydrochloric acid, or its precursor. The pyloric glands secrete mucigen and proenzymes for pepsin and rennin. The second coat, known as submucosa, consists of loose fibers of connective and elastic tissue, containing nerves and blood and lymph vessels. The third coat is muscular, with three layers of muscles, of which the outer are longitudinal, the middle, circular, and the inner, oblique. The fourth coat is known as the serosa and consists of the peritoneum which closely covers the entire stomach, except at the curvatures where the peritoneum is reflected to the lesser and greater omenta.

The high level of secretory and motor activity of the stomach requires an abundant blood supply. The stomach is amply supplied with blood from the celiac axis. The main drainage of the venous blood is into the portal vein. Innervation of the stomach plays an important role in its functional disorders. The nerve supply of the stomach comes exclusively from the autonomic nervous system, of which the parasympathetic division is represented by the vagus nerve, and the sympathetic by branches from the celiac plexus.

**Physiology.** The stomach has a secretory and a motor function. The fundus serves largely as a reservoir for the ingested food, softening and saturating it with gastric juice. There is little peristalsis in this section. When the food enters the stomach, it is saturated with salivary secretion, and the diastatic action of this secretion continues for a while in the fundus, until it is checked by the acidity of the gastric juice. Psychic factors are of considerable importance in the secretion of the gastric juice, and it is well known that shock and grief may inhibit or suppress this secretion.

Gastric juice contains from 0.4 to 0.5 hydrochloric acid, and also chlorides of sodium and potassium, nitrogenous elements, and phosphates. The mucin in the juice protects the gastric mucosa from injury. The gastric juice also has antiseptic value. Its digestive function consists in softening the cellulose fibers and in starting the digestion of proteins, converting them to peptones. Normal gastric secretion also has a definite relation to normal blood formation and is of importance in calcium and iron metabolism.

The motor function of the stomach consists of active peristaltic waves in the antrum which churn and macerate the food, preparatory to its ejection, in small portions, into the duodenum.

**Pathology.** The stomach is subject to several functional and organic disorders. Among them are dysfunctions of gastric secretion, such as hypoacidity and hyperacidity; gastritis; peptic ulcer; and carcinoma. *See also* Dyspepsia; Gastritis; Peptic Ulcer; Surgery; Tumors. B. Van R.

**STOMATITIS.** *See* Foot-and-Mouth Disease.

**STONE, HARLAN FISKE** (1872-1946), American jurist and educator, was born at Chesterfield, N. H., Oct. 11, 1872. He was educated at Amherst College, where he grad-

uated in 1894, and at Columbia University Law School, where he received his LL.B. in 1898. He was admitted to the New York bar in the same year. In 1899 he returned to Columbia as a lecturer on law, and in 1902 was appointed professor, retaining the post until 1905; from 1910 until 1923 he was dean of the Columbia School of Law. In 1924, President Calvin Coolidge appointed Stone United States Attorney General and, in 1925, an associate justice of the United States Supreme Court. In 1941, in succession to Charles E. Hughes, President Franklin D. Roosevelt appointed him Chief Justice. Among Stone's books is *Law and Its Administration* (1915); his wide knowledge of his subject and the precision with which he used this knowledge earned the respect of his contemporaries. Stone died in Washington, D. C., Apr. 22, 1946. R. T.

**STONE, LUCY** (1818-1893), American reformer and women's rights leader, was born on a farm near West Brookfield, Mass., Aug. 13, 1818. Refused a college education by her father, she studied at home, taught school, and then worked her way through Oberlin College from which she graduated in 1847. She at once began lecturing, particularly in the interests of the anti-slavery movement and women's rights. She participated in the first national Women's Rights convention in 1850. In 1855 she was married to Henry Brown Blackwell (1824-1909), but kept her maiden name. In 1858, while living in New Jersey, she allowed her household goods to be sold for taxes and then published a protest pamphlet on "taxation without representation." Active in the movement for woman suffrage and equal rights, she devoted much of her time to lecturing in their interest. She helped found the *Woman's Journal* in 1870 and two years later she and her husband assumed its joint editorship, which they retained for the remainder of their lives. She died in Dorchester, Mass., Oct. 18, 1893. T. R. H.

**STONE AGES.** *See* Archaeology (*Prehistoric Archaeology*).

**STONE BORER,** the popular name for bivalve mollusks which bore into stone. They belong to three different genera; the date shells, *Lithodomus,* the piddocks, *Pholas,* and *Saxicava. Lithodomus* is found in Florida, the West Indies, and Europe. When young it attaches itself by byssuses but later on bores into the stone, forming a hole to fit its shell. *Saxicava* is nearly cosmopolitan in distribution. It is very common north of Cape Cod, burrowing in limestone. *Pholas,* with an elongated and very convex shell, is found in all seas. Some species, as *P. costata,* reaching 6 in. in length, are used for food. *See also* Piddock. V. L. L.

**STONECHAT,** a small bird (5 in.) of the thrush family, *Saxicola torquata,* which, in many forms, inhabits the Old World from the British Isles to Japan and south to India and the Cape of Good Hope. It is allied to the wheatears and the true redstarts. The male is mainly chestnut pink below and dark brown above, with a black head and white markings on the neck and wings; the head and neck of the female are brown like the back. The stonechat, so called because of the similarity of its alarm note to the clicking together of two pebbles, lives in open, bushy country. It feeds chiefly upon insects and their larvae, and nests in low and preferably thorny shrubs. H. G. De.

**STONE, CLAY, AND GLASS INDUSTRIES.** An abundance of the necessary raw materials in most parts of the country has made the United States the world's foremost producer of stone, clay, and glass products.

**Evolution.** The stone, clay, and glass industries are one of the oldest major groups in the history of manufacturing. Their origin in many instances has been lost in antiquity. Products of glass were formed by Stone Age man from a volcanic ash known as obsidian. Obsidian is translucent in character, readily broken into sharp, elongated pieces which can be fashioned into objects of various kinds. More advanced cultures used obsidian in the manufacture of mirrors and jewelry. Products of stone and clay have similarly remote historical origins and have been found all over the world. Stone, clay, and glass products were identified as articles of commerce as early as the Bronze Age and continued to be an important phase of commercial and economic development in the history of mankind. More than many other industries, stone, clay, and glass manufactures resisted the introduction of modern manufacturing techniques and maintained for a relatively long period efficient but antiquated methods of manual production. For centuries there was little progress in the methods of manufacturing. The arts were passed down from generation to generation and often guarded with extreme jealousy by those well-versed in the production techniques. Almost every country in the world developed its own particular type of product, and such identifying names as Venetian glass, Dresden china and Bohemian ware are typical of the individual characteristics of stone, clay, and glass manufacturing. As a result, the volume of production remained small, and the output was limited largely to the needs of the communities where the products were sold. Until the 1870's, production methods had shown very little change, aside from certain refinements of existing techniques. In fact, not until the twentieth century did the stone, clay, and glass industries emerge from relative insignificance to major importance in manufacturing. There were greater and more important changes in the first quarter of the present century than in the thirty or forty preceding centuries.

**Development in the United States.** Although many of the basic techniques and processes of stone, clay, and glass manufacture were developed in Europe, it remained for the United States to introduce large-scale production and mechanization. Today this country is the undisputed leader in production. There are five basic reasons for its dominance. The first is the presence of large and favorably situated deposits of raw materials. These include materials principally derived from the earth in the form of stone, clay, sand, gypsum, and asbestos and, of lesser importance, barium, borax, feldspar, mica, silica, and talc. One or more of the foregoing can be found in almost any section of the country in sufficient quantities to make production possible. In the second place, there are adequate supplies of fuel and motive power. Perhaps one of the principal reasons for the slow development of the stone, clay, and glass industries in Europe has been the inadequacy of fuel. Large quantities of fuel are consumed in relation to the quantity of products produced. In the production of cement, for example, one-half ton of coal is consumed for every ton of cement produced. The United States is well supplied with coal and can supplement this fuel with oil and natural gas. Thirdly, there is an extensive domestic market, which was stimulated by a growing population and an excellent transportation system. Fourthly, the country has a large and sufficiently skilled labor force. Finally, the United States has led in the mechanization of production techniques. *See also* Engineering Materials; Glass. R. M.

**STONE CRAB,** a very thick-shelled true crab, *Menippe mercenaria,* occurring along the southeastern coasts of the United States and highly prized as an article of food. The stone crab of America lives in burrows just below low-tide line from North Carolina to Mexico and along the coast of Cuba. It attains a size of 5 in. across the back. Formerly found in abundance, this crab has been caught so extensively for food that it was threatened with extinction, and protective measures had to be taken. Since much of the choicest meat is contained in the larger claw, some fishermen have adopted the procedure of breaking off this claw and releasing the crab to grow a new one. In other parts of the world, decapod crustaceans belonging to different groups, notably the anomuran crabs related to the hermit crabs, are commonly referred to as stone crabs. F. A. C.

COURTESY OF THE U. S. FISH AND WILDLIFE SERVICE

*The stone crab,* Menippe mercenaria *of the family Xanthidae, is found in coastal waters of the southern United States.*

**STONECROP.** *See* SEDUM.

**STONE FLY,** the common name of members of the insect order Plecoptera. They have long antennae and a pair of short to long tail-like processes at the end of the abdomen. The wings have numerous cross veins; the front wings are narrow, with rather parallel sides; and the hind wings, which are about twice as wide, fold under the front ones when at rest. Many of the stone flies are very slender, and the wings may fold so as to cover the sides of the body. The nymphs are aquatic and most of them are predaceous upon other aquatic insects, crawling over stones, sand, and submerged branches in search of prey. A few kinds are herbivorous, feeding on aquatic plants. A large part of their diet consists of May flies, but stone flies in turn are an important fish food. They vary in size from less than ½ in. to over 1 in. C. H. Cu.

**STONEHAM** [sto′nəm], a town in northeastern Massachusetts, situated in Middlesex Co., 10 mi. north of Boston, of which it is a residential suburb. Founded in 1645, it was originally a part of Charlestown and for a while was called Charlestown End. In 1725 it was incorporated as a separate town. The town meeting administers the community. Within the town's limits is Spot Pond, a storage basin for the metropolitan water district, and more than 700 acres of the Middlesex Fells Reservation. The residents of Stoneham early developed small industries, such as shoemaking, in their own homes, and they were pioneers in the use of steam power and laborsaving machinery in shoemaking, including the heeling machine invented by John Hill in 1862. Shoes are a leading item of the factory output, which includes window shades, chemicals, drugs, upholstered furniture, and confectionery. The Boston and Maine Railroad supplies transportation. Pop. 1950, 13,229.

**STONEHENGE** [sto′nhɛnj], the most famous of prehistoric megalithic monuments. Stonehenge is situated on Salisbury Plain in southern England. At present visible are traces of an outer ditch, some outlying stones, an outer circle of trilithons, each consisting of two sarsen stone uprights with a lintel held in position by a tenon and mortise arrangement, an inner circle of monilithic bluestones from the Prescelly Hills of Wales, a U-shaped arrangement of five sarsen trilithons, and a similar setting of bluestone monoliths.

Excavation has revealed three concentric circles of holes in the chalk subsoil between the bank on the inner side of the ditch and the stone circles, an outer one noted by the early antiquary John Aubrey and two inner ones (Y & Z holes). It is evident that, like a cathedral, Stonehenge took shape over a long period of time. The first monument was a large earthwork (c. 1800 B.C.). About 150 years later large bluestone blocks, 40 tons or more in weight, were brought from Wales to construct two concentric circles of stones oriented so that the midsummer sun as it rose would shine upon a recumbent altarstone. The bluestones from Pembrokeshire, Wales, originally 82 of them, were probably dragged on sledges to the Welsh coast where boats carried them by sea and up the river Avon to the building site. A 70-ft.-wide, embanked avenue, first detected by air photography, approached the temple from the river, about 1½ mi. away. A third construction (c. 1500 B.C.) consisted of a circle of thirty uprights capped by stone lintels, surrounding a horseshoe of trilithons. The new stones were dragged from the Marlborough Downs 25 mi. away. A. H. Sw.

**STONE MOUNTAIN,** the name both of a dome-shaped granite mountain in De Kalb County, near Atlanta, Ga., and of an adjoining city with a population of 1,408. The mountain rises more than 650 ft. and covers an area of about 2 sq. mi. The northern slope rises as a sheer cliff for 300 ft. and then assumes a dome appearance with an almost naked rock surface, except for an occasional crevice with small trees and shrubs. The bulk which rises above the plain has been estimated to encompass seven and one-half billion cubic feet of granite. On the precipitous northern face of Stone Mountain, the Stone Mountain Memorial to the Confederacy is being carved. The plan calls for a huge relief of General Lee and other heroes followed by Confederate soldiers. The idea was conceived in 1916 by the sculptor Gutzon Borglum, who began to execute his design the following year. His design was 200 ft. high and 1,300 ft. long. In 1924 the head of Robert E. Lee was unveiled, but as a result of a disagreement between Borglum and members of the Stone Mountain Association, which was financing the project, Borglum was dismissed. In 1926 Henry Augustus Lukeman was engaged to complete the project. Lukeman destroyed Borglum's head of Lee, and executed one of his own. In 1929 Borglum was recalled, but the project has been suspended because of a lack of funds. P. H. N.

**STONE PLANTS,** also called stone-mimicry plants, a unique group of South African desert plants which closely

resemble the pebbles among which they grow. The small plant body is almost entirely hidden beneath the sandy or gravelly soil, the only part showing being one or two pairs of exceedingly fleshy leaves, which often assume the colors of nearby stones. Except when they bloom, they are scarcely distinguishable on the desert floor. The flowers, consisting of many narrow petals, often brightly colored and glistening in texture, are frequently larger than the rest of the plant. They belong to the same family as the fig-marigold, and include several distinct genera, among them *Mesembryanthemum,* most of which are in cultivation in the United States. They make interesting and satisfactory plants for indoor culture in a south window.

In these same genera, and in several others, are the windowed plants, which have a translucent membrane over the part of the leaf that is exposed. In the burning deserts of

COURTESY OF THE NEW YORK BOTANICAL GARDENS

*Stone plants of the South African desert*

South Africa, these plants grow completely submerged in the sand except for the tip of each windowed leaf. Through the "window" the sun's rays are filtered to the green tissues of the buried plant. A few windowed plants occur in other families. C. H. Wo.

**STONE ROLLER,** *Campostoma anomalum,* a small minnow, of the family Cyprinidae, adapted for life on the bottom of streams. Found in North America east of the Rocky Mountains, it is a unique minnow with a very long intestine coiled spirally about the air-bladder. An herbivorous form, it scrapes diatoms and other small material off stones, employing a cartilaginous pad on the inside of the lower lip as a scraper. Ordinarily it is a dull or brassy colored fish, but in early spring the males assume a bright orange nuptial coloration with a dark bar in the dorsal, anal, and caudal fins. Fairly large, sharp, breeding tubercles line the top of the head and back. The males gather in groups just above riffles and dig cup-shaped nests. Their tubercles help protect them from injury by the sand and gravel which they toss out of the nests by sideward motions of the head. The eyes of many stone rollers are destroyed when they are struck by the tubercles of a pugnacious neighbor. They reach a length of 6 to 8 in. and serve as natural forage for game fishes. E. C. R.

**STONES RIVER, BATTLE OF.** *See* MURFREESBORO, BATTLE OF.

**STONEWORTS.** *See* ALGAE; PLANT SYSTEMATICS.

**STORAGE BATTERY, ELECTRICAL.** A storage battery is an electrochemical device capable of the following:

1. Accepting direct-current electrical energy (charging);
2. Retaining this energy in the form of chemical energy (charge retention);
3. Releasing its energy as direct-current electrical power on being connected to an external circuit (discharging); and
4. Repeatedly performing functions 1, 2 and 3 (cycling).

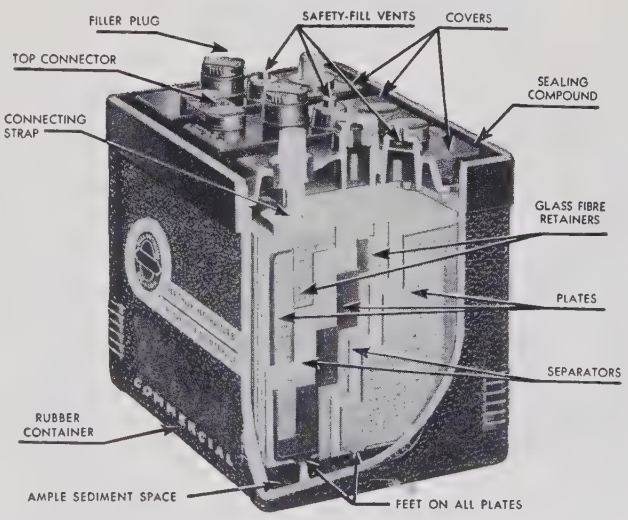
Storage batteries are also called secondary batteries, to distinguish them from primary batteries, which are not capable of Functions 1 and 4.

Storage batteries commonly used may be classified in either of two major categories: (a) lead-acid type; and (b) alkaline type.

## LEAD-ACID STORAGE BATTERIES

**Construction.** Lead-acid storage batteries are made up of one or more identical units called cells having a nominal potential of 2 volts each. Thus the ordinary 6-volt automobile battery has three cells connected in series.

*Plates.* Each cell consists essentially of electrodes of lead in two or more of its chemical forms in an acid electrolyte, or solution—usually dilute sulphuric acid. The electrodes are commonly referred to as positive plates and negative plates. These plates consist of a structural frame and electrical conductor called the grid, which is made of metallic lead alloy, and the active material of lead in other forms (chemical states), which fills the grid spaces and does the electro-chemical work required. The grid is cast from an alloy of lead, antimony (6 to 12 per cent in automotive practice), and minor fractional percentages of tin, bismuth, arsenic, and other elements. The active material in the positive plate is lead peroxide, $PbO_2$. Its physical form is that of a chocolate-brown, highly porous mass of self-bonded crystals that is readily permeated by the electrolyte. The negative-plate active material is a porous




COURTESY OF THE WILLARD STORAGE BATTERY CO.

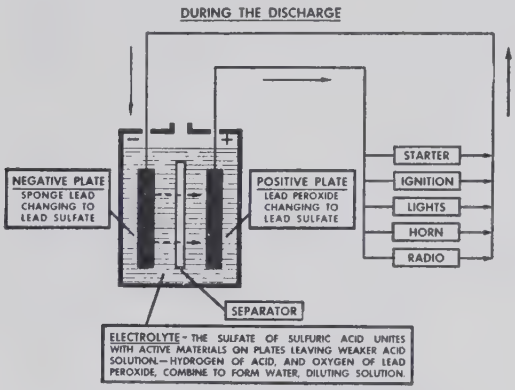
*Cut-out view of one type of lead-acid storage battery, showing principal parts*

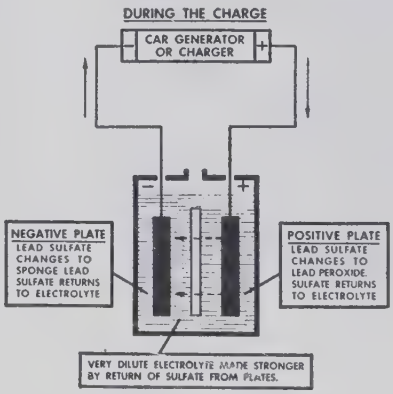
mass of finely divided self-bonded particles of metallic pure lead plus a minor portion of additives that have the function of maintaining the porosity of the negative active material as it goes through the process of being repeatedly charged and discharged during the life of the battery.

*Separators.* The plates are assembled by interleaving

alternate positive and negative plates together with separators that prevent their touching each other. These separators must be acid-resistant and readily permeable to electrolyte and electric current. This permeability must be of a microporous nature to prevent penetration by particles of active material that become loosened from the positive plate during the cycling life of the battery. Separators are usually flat on the side next to the negative plate and grooved or ribbed on the side bearing against the positive plate.

The most commonly used separator material is wood that has been chemically treated to remove much of the resin and acids. Certain kinds of cedar appear to have the best characteristics, closely followed by fir. Synthetic separators of microporous rubber are also widely used and are especially effective where the battery may encounter high climatic or charging-rate temperatures. Separators may be reinforced with an auxiliary sheet of porous material such as glass fiber or perforated rubber. This reinforcement is placed against the face of the positive plate and is an aid in restraining the shedding of active material during the life of the battery when the latter is subject to heavy cycling duty.


DURING THE DISCHARGE
NEGATIVE PLATE
SPONGE LEAD CHANGING TO LEAD SULFATE
POSITIVE PLATE
LEAD PEROXIDE CHANGING TO LEAD SULFATE
STARTER
IGNITION
LIGHTS
HORN
RADIO
SEPARATOR
ELECTROLYTE - THE SULFATE OF SULFURIC ACID UNITES WITH ACTIVE MATERIALS ON PLATES LEAVING WEAKER ACID SOLUTION.— HYDROGEN OF ACID, AND OXYGEN OF LEAD PEROXIDE, COMBINE TO FORM WATER, DILUTING SOLUTION.


DURING THE CHARGE
CAR GENERATOR OR CHARGER
NEGATIVE PLATE
LEAD SULFATE CHANGES TO SPONGE LEAD SULFATE RETURNS TO ELECTROLYTE
POSITIVE PLATE
LEAD SULFATE CHANGES TO LEAD PEROXIDE. SULFATE RETURNS TO ELECTROLYTE
VERY DILUTE ELECTROLYTE MADE STRONGER BY RETURN OF SULFATE FROM PLATES.

*ELECTROCHEMICAL ACTION IN A LEAD-ACID STORAGE BATTERY*

*(Spelling of "sulfate" and "sulfuric acid" is that preferred by the AABM.)*

COURTESY OF THE ASSOCIATION OF AMERICAN BATTERY MANUFACTURERS

**Chemistry of Cells.** The electrolyte (solution) of the lead-acid battery is usually dilute sulphuric acid ($H_2SO_4$), which will vary with the state of charge of the battery, being at a maximum when the battery is fully charged and at a minimum when it is completely discharged.

*Discharge Reactions.* The lead storage cell when fully charged consists of a lead (Pb) plate as the negative (cathode) terminal and a lead dioxide ($PbO_2$) plate as the positive (anode) terminal. Both plates are immersed in an electrolyte of sulphuric acid. During discharge, the active materials and electrolyte in the battery undergo a chemical change. The lead at the negative plate loses two electrons ($e$), whereas the lead dioxide at the positive plate gains two electrons. At the negative plate the reaction is:

$$Pb \rightarrow Pb^{++} + 2e$$
$$Pb^{++} + SO_4 \rightarrow PbSO_4 .$$

At the positive plate, the simultaneous reaction is:

$$PbO_2 + 2H^+ \rightarrow PbO + H_2O - 2e .$$

The lead monoxide (PbO) thus reacting with the sulphuric acids ($H_2SO_4$) produces the following result:

$$PbO + H_2SO_4 \rightarrow PbSO_4 + H_2O .$$

Thus, during the discharge both plates become covered with lead sulphate ($PbSO_4$). At the same time the specific gravity of the electrolyte is lowered because some of the sulphuric acid has been converted into water.

*Charge Reactions.* Upon charging, the original conditions of the battery are restored by passing through it a current in the direction opposite to that produced by the battery while it is in service; that is, the lead sulphate at the positive plate is restored to lead dioxide ($PbO_2$) and at the negative plate lead sulphate is restored to lead (Pb). Thus, at the negative plate the hydrogen ion gives up two electrons, resulting in the following reaction:

$$PbSO_4 + 2H^+ + 2e \rightarrow Pb + H_2SO_4 .$$

At the positive plate, the sulphate ion gives up two electrons and the reaction is:

$$PbSO_4 + SO_4^{=} - 2e \rightarrow Pb\,(SO_4)_2 .$$

Since plumbic sulphate $Pb\,(SO_4)_2$ is not stable in water, the final reaction is:

$$Pb(SO_4)_2 + 2H_2O \rightarrow PbO_2 + 2H_2SO_4 .$$

The charging reaction results in an increase in the specific gravity of the electrolyte. The cycle of charge and discharge may be repeated many times until some portion of the physical structure of the battery fails because of electrolysis of the metal or oxidation of the separator material. The majority of batteries have a specific gravity of about 1.280 when fully charged, but this may be varied between 1.225 in tropical climates and 1.300 in cold climates. The minimum specific gravity when the battery is discharged will vary between wide limits depending on the design of the battery. Generally speaking, a specific gravity of 1.150 indicates that the battery is discharged by 90 per cent or more.

*Efficiency.* The efficiency of a battery—that is, its ability to accept, store, and deliver energy—is markedly affected by change in temperature, as are most chemical and electrochemical reactions. Lowered temperature results in lowered efficiency. For example, an automobile battery is only 65 per cent as efficient at 32° F. as at 80° F., and only 40 per cent as efficient at 0° F. Increased viscosity in the engine oil as a result of cold weather adds to the load of starting in about the same ratio; thus 2½ times as much power is required at 0° F. as at 80° F.

The efficiency is also materially affected by the rate at which a battery is charged or discharged. It is most efficient when charged and discharged slowly. It is this characteristic which largely controls the design of a battery. If the unit is to be subject to low rates of charge and discharge over long periods, relatively few and compara-

tively thick plates may be used. If the requirements call for rapid charge and high rates of discharge as in engine starting, a large number of thin plates must be used. Hence, the plate surface governs the rate at which a lead-acid storage battery will perform its electrical and electrochemical functions.

### ALKALINE STORAGE BATTERIES

In alkaline batteries, the electrolyte is basic rather than an acid. The most familiar alkaline storage battery is the Edison cell type, often referred to as the nickel-iron-alkaline type of cell. Another alkaline battery is the nickel-cadmium type. The nickel-iron and the nickel-cadmium are more common in Europe.

The electrolyte is an aqueous solution of potassium and lithium hydroxide and does not at any stage cause a disintegration or solution of the active materials. Since only a relatively small quantity of the potassium and lithium hydroxides is absorbed by the higher nickel oxide electrode, the composition of the electrolyte does not vary appreciably throughout the cycle of charge and discharge. The conductivity and specific gravity of the electrolyte are therefore practically constant. The lithium hydroxide permits of greater utilization of the active materials in the higher nickel oxide electrode, and its use results in greater capacity and increased life. It is therefore an indispensable component of the electrolyte.

**Construction.** The active materials are packed in perforated nickeled-steel tubes or pockets to form the plates. The positive plate is usually in the form of a number of vertical tubes placed side by side. Flake nickel is tamped in alternate layers with the nickel hydrate in the positive tube to improve its electrical characteristics. The tubes are reinforced by eight encircling seamless-steel rings mounted at equally spaced intervals on the grid. The negative plate is similar except that finely divided oxide of iron is used as the active material and is contained in rectangular perforated pockets instead of tubes.

*Group Assembly.* The positive and negative plates are assembled into positive and negative groups. This is done by passing a connecting rod through holes at the top of the grids. Steel washers are used to obtain proper spacing, the middle spacer being the base of the pole piece. A lock washer and nut are drawn up tight at each end of the connecting rod, binding the plate group firmly together. All washers, nuts, connecting rods, and terminal posts, like the plates, are of nickeled steel.

*Element Assembly.* The plate groups are assembled into complete elements by intermeshing the plates. The negative group always contains one more plate than the positive, so that both outside plates are always negative. Insulation between the alternate positive and negative plates is accomplished by means of vertical hard rubber pins running their entire length. Rubber sheets insulate the outside negatives from the sides of the container, while the edges of the plates are insulated from the bottom and the other sides of the container by means of hard-rubber frames. These frames also serve the purpose of separating the grids and holding the plates in correct alignment, and are so designed as to permit free circulation of the electrolyte.

*Container.* Potassium hydroxide, the electrolyte, does not attack steel; and this fact is taken advantage of in the nickel-iron-alkaline cell in order to obtain the strength and durability of steel in the container as well as in the elements. The container, like the elements, is made of nickeled steel with all joints welded.

The cell cover, also of nickeled steel, is welded in place. Soft-rubber bushings, expanded by steel rings and hard-rubber screw washers, or gland caps, insulate the pole pieces where they project through the cover, and provide an airtight and liquid-tight packing. All cells are coated with a heavy insulating paint, after which a protective film of rosin petroleum jelly is applied to the cell tops. Connectors are secured by tightening down nuts and are removed by means of a small jack after loosening the nut.

*Battery Assembly.* Nickel-iron-alkaline cells are assembled into batteries in hardwood trays. Steel suspension bosses, previously spot-welded to the sides of the cell containers, fit into hard-rubber buttons recessed in the tray slats. This assembly supports each cell in place and insulates it from the tray and adjacent cells.

**Chemistry of Cells.** The active materials of storage cells do not store electricity as such but are so chemically and physically changed by applied electrical energy as to be capable of producing electrical energy through conversion to their former state.

*Charge Reactions.* The chemical changes that occur when the nickel-iron-alkaline cell is charged may be represented by chemical equations. The potassium hydroxide ($2KOH$) electrolyte ionizes into $2K^+$ and $2OH^-$. The chemical reactions resulting at the negative plate consisting of ferrous oxide ($FeO$) and at the positive plate consisting of nickel oxide ($NiO$) are respectively as follows:

$$FeO + H_2O + 2K^+ \rightarrow Fe + 2KOH + 2e$$

$$2KOH \xrightarrow{\text{ionizing}} 2K^+ + 2OH^-$$

$$NiO + 2OH^- + H_2O \rightarrow NiO_2 + 2H_2O - 2e.$$

*Discharge Reactions.* The chemical changes that occur when the cell is discharged, at the negative and positive plates, are, respectively, as follows:

$$Fe + 2OH^- \rightarrow FeO + H_2O - 2e$$

$$2KOH \xrightarrow{\text{ionizing}} 2K^+ + 2OH^-$$

$$NiO_2 + H_2O + 2K^+ \rightarrow NiO + 2KOH + 2e.$$

**Operating Characteristics.** The average discharge voltage per cell at the normal 5-hr. discharge rate is approximately 1.20 as compared with 2 volts for the lead-acid battery, so that more Edison cells than lead cells are needed to produce a battery of the same voltage. The relative over-all size of the batteries is approximately the same, however, and on an equivalent kilowatt-hour basis the Edison battery is lighter.

The state of charge of this type of cell must be determined by electrical test, i.e., by voltage under charge or discharge. The charge cannot be determined by hydrometer reading, since the electrolyte specific gravity does not vary with state of charge. *See also* ELECTROCHEMISTRY; ELECTROLYTES; MOTOR VEHICLES. L. E. W.

**STORAX** [sto′ræks], a balsam, semiliquid, grayish-brown in color, having a characteristic odor and taste, obtained from the trunk of *Liquidambar orientalis,* a native of Asia Minor, and known in commerce as Levant, or liquid, storax. It is used in the treatment of scabies and of other parasitic skin diseases. It is also used in perfumery, and as imbedding material in microscopy. A fragrant resin derived

from the storax tree, native to the Mediterranean region, was once much used for incense and perfume. *See also* LIQUIDAMBAR. J. A. Bo.

**STORK,** any one of a number of species of very large wading birds, allied to the herons, which form the family Ciconiidae. They are found in temperate and tropical regions throughout the world, excepting that of the oceanic islands. They are characterized by long legs, a long neck, and a long,

JOSEPH ADAMS FROM FREDERICK LEWIS

*MALAY STORKS*

heavy bill; their plumage may be mainly gray, metallic-glossed black, or black and white, but a few possess patches of brighter colors. Storks usually inhabit open plains or marshy ground, where they feed upon large insects, mollusks, amphibians, reptiles, and other forms of animal life. They build massive nests of sticks on cliffs, lofty trees, or even occupied houses. They are voiceless, but during the breeding season indulge in grotesque courtship dances, which are accompanied by loud noises made by clattering together the upper and lower halves of the bill. The white stork of the Old World, *Ciconia ciconia,* is conspicuous in many of the towns and has entered largely into popular proverbs, tales, and fables. The only stork occurring in the United States, *Mycteria americana,* known as the wood ibis, is locally common in the southern parts of the country from Florida to California. H. G. De.

**STORM, THEODOR** [shtɔ'rm] (1817-1888), German poet and writer of prose fiction, was born at Husum, in Schleswig-Holstein, on Sept. 14, 1817, of a well-established, middle-class family. He attended the universities of Kiel and Berlin and began his literary career in 1843 when with Tycho and Theodor Mommsen he published *Liederbuch dreier Freunde,* which contains his earliest poetry. In 1843 Storm established a law practice in Husum, and in his leisure time he began to write short tales. During the struggle between the Danes and the German element for control of Schleswig-Holstein, Storm, who was outspoken in the German cause, lived in Germany from 1853 to 1864. Upon the incorporation of Schleswig-Holstein into Prussia, he returned to Husum and to a position of prominence in the local government. His wife, Konstanze Esmarch, died in 1865, leaving him with seven children, and shortly afterward he married Dorothea Jensen, a childhood sweetheart. During the last part of his life he carried on an active correspondence with Edward Mörike, Paul von Heyse, and other prominent writers of his day. In 1880 he retired from public life to the nearby town of Hademarschen, and there he died on July 4, 1888.

Storm's stories (*Novellen*) usually express a somber, reflective mood and bear evidence of the author's lyric gifts. They are filled with descriptions of the coast and moorland of his native province, to which he always remained closely attached, and with memories of the old city of Husum. In the genre of the *Novelle,* Storm strove toward perfection of form, and his work shows a clear development from beginning to end. The perennially popular *Immensee* (1852) and the later *St. Jürgen* (1867) are representative of his early sentimental stories, in which a note of resignation is usually a prominent feature. In the next period he showed more variety, as in *Viola Tricolor* (1873) a psychological study of a second marriage, *Pole Poppenspäler* (1874), a charming children's story, and *Psyche* (1875), a sunny tale of a young artist's love. Finally Storm turned to more realistic, historical tales, written for the most part in the slightly archaic style of old chronicles; among these are *Aquis Submersus* (1877), *Eekenhof* (1878), *Zur Chronik von Grieshuus* (1884), and, the culmination of all Storm's stories, *Der Schimmelreiter* (1888). Storm's reputation as a lyric poet was established by the publication in 1852 of a book of verse in the Romantic vein. J. F. McM.

**STORM LAKE,** a city and summer resort in northwestern Iowa, the county seat of Buena Vista Co., situated on the lake of the same name, about 60 mi. east of Sioux City. Corn, oats, and livestock are raised in the region. The community has the mayor-council form of government. Storm Lake is the seat of Buena Vista College. Transportation is supplied by the Illinois Central and the Chicago, Milwaukee, St. Paul and Pacific railroads. Local industries include meat packing, hog and poultry processing, canning, and the manufacture of butter, medical appliances, and silo tanks. Pop. 1950, 6,954.

**STORY, JOSEPH** (1779-1845), American jurist, was born at Marblehead, Mass., Sept. 18, 1779, and was educated at Harvard University where he graduated in 1798. Afterwards he studied law at Marblehead and at Salem, where he was admitted to the bar in 1801. He was the representative of Salem in the Massachusetts legislature from 1805 to 1807. In 1808 Story was elected to Congress, and served one term there, until March 1809. He was speaker of the Massachusetts legislature in 1811, and in November of the same year was appointed by President James Madison as an associate justice of the United States Supreme Court. During the War of 1812 he was responsible for many important decisions on the subject of maritime prizes. In 1829, Story was appointed the first Dane professor of law at Harvard University, a position which he retained for the rest of his life, while remaining a justice of the Supreme Court. Among his books are *Commentaries on the Law of Bailments* (1832), *Commentaries on the Constitution of the United States* (3 vols., 1833), *Commentaries on Equity Jurisprudence* (2 vols., 1836), *Law of Agency* (1839), *Law of Partnership* (1841), and *Law of Bills of Exchange* (1843). Story was a determined opponent of slavery and was very unpopular in those states where it prevailed. As a justice of the Supreme Court he was largely responsible for all subsequent American equity jurisprudence. He died at Cambridge, Mass., Sept. 10, 1845. R. T.

**STORY, WILLIAM WETMORE** (1819-1895), American sculptor, poet, and author, son of the eminent jurist, Joseph Story, was born in Salem, Mass., Feb. 12, 1819. He graduated from Harvard in 1838, later went to Italy to study art, and settled permanently in Rome about 1848. His reputation as a sculptor, which was high during his lifetime, has declined in the twentieth century. His best known work is a statue of Cleopatra first exhibited in London in 1862. In general, his works are pervaded by a literalness and theatricalism more appropriate to writing than to sculpture. His career is recorded by Henry James in *William Wetmore Story and His Friends.* Story died in Vallombrosa, Italy, Oct. 7, 1895. A. TenE. G.

**STOSS, VEIT** [shto's] (c. 1440-1533), sculptor, was born in obscure circumstances, his birthplace being claimed by both Poland and Germany. He worked in Kraków from 1477 to 1496, where he was highly regarded, and where he left one of his greatest works, the High Altar of the Church of Our Lady (1477-1489). From 1496 until his death in 1533, Stoss worked in Nürnberg, weathering a period of disgrace and legal prosecution arising out of a confessed dishonesty. A son, Stanislas, was left in charge of the workshop established in Kraków.

Though Stoss's origin is controversial, his style and the construction of his large religious works correspond closely to the late Gothic types of southern Germany. Brilliantly realistic in detail, these compositions have a general effect of artificial intensity due to the strained postures of the figures and the overelaborate folds of the heavy drapery. The folds, in fact, often become so complex as to develop a fascination and a sense of drama all their own.

The outstanding work by Stoss in Nürnberg is the great Rosary, containing a representation of the Annunciation (1517-1518), which hangs over the choir in the Church of St. Lawrence. Like the Altar in Kraków, it is carved in wood and preserves the elaborate polychromy of late Gothic work. Stoss also did some stone carving, notably the tombs of two Polish archbishops in the Cathedral of Gnesen. L. R.

**STOUGHTON** [sto'tən], a town in east central Massachusetts, which includes the village of Stoughton and several other villages, situated in Norfolk Co. about 16 mi. south of Boston, that is in an area marked principally by truck gardening. Founded about 1713 and originally a part of Dorchester, Stoughton was incorporated as a town in 1743. The local government is the council-manager type. The town was named in honor of a colonial governor. During the Revolution it was an important supply center for colonial troops. Transportation is provided by the New York, New Haven and Hartford Railroad. Manufactures include woolen knit goods, shoes, shoe lasts and shoe trees, rubber specialties, elastic webbing, raincoats, and confectionery. Pop. 1950, 11,146.

**STOW, JOHN** [sto'] (1525-1605), English antiquary and historian, at first followed the trade of tailor in London, but after 1560 devoted his entire time to antiquarian research. He edited the works of Chaucer in 1561, and published *A Summarie of Englyshe Chronicles* in 1565, and *The Annales of England* in 1592. Stow's principal work, *A Survay of London* (1598), is a description of the city and its customs in Shakespeare's time. His accurate first-hand observation and careful scrutiny of documentary materials make him the most dependable of Elizabethan historians. He died in London, Apr. 5, 1605. W. R.

**STOWE, HARRIET ELIZABETH BEECHER** [sto'] (1811-1896), American author, was born June 14, 1811, in Litchfield, Conn. Daughter of the staunch Calvinist conservative, the Reverend Lyman Beecher, and sister of five clergymen, among them the famous pulpit orator, Henry Ward Beecher, she grew up and was educated in the waning Puritan atmosphere of Connecticut. In 1832 she moved to Cincinnati, where her father had been made president of Lane Theological Seminary. Here she gained her first direct

*HARRIET BEECHER STOWE*

BROWN BROTHERS

knowledge of slavery. Here also, in 1836, she married Professor Calvin E. Stowe, who had encouraged her writing, and by 1850, when her husband accepted a position at Bowdoin College in Maine, she was the mother of seven children. Back in the New England atmosphere of rising religious abolitionism, she poured her own indignation over the Fugitive Slave Law into *Uncle Tom's Cabin* (1851-1852), the novel which brought her fame. Despite its artistic faults and its unrelieved sentiment, it was a great humanitarian document, and its world-wide success made it one of the most potent pieces of propaganda ever written. A second antislavery novel, *Dred; a Tale of the Great Dismal Swamp* (1856), was a sounder piece of writing, but never became as popular. Mrs. Stowe's later fiction was great in volume but uneven in quality, her best work lying in her stories of the local life of her own Puritan New England. *The Minister's Wooing* (1859), *The Pearl of Orr's Island* (1862), and *Oldtown Folks* (1869) are acute psychological and spiritual studies of real people; only occasionally are they marred by the author's characteristic fault of using a story to preach an abstract principle. Mrs. Stowe died July 1, 1896, in Hartford, Connecticut. *See also* UNCLE TOM'S CABIN. E. C. Sh.

**STOWE,** a residential township in southwestern Pennsylvania, situated in Allegheny Co., on the Ohio River and on the northwestern outskirts of Pittsburgh, of which it is a suburb. The government is the mayor-councilmanic type. The principal local industry is the manufacture of railroad equipment. Pop. 1950, 12,210.

**STRABISMUS.** *See* EYE (*Eye Diseases; Eye Surgery*).

**STRACHEY, GILES LYTTON** [stre'tshi] (1880-1932), English historian and essayist, was born in London, Mar. 1, 1880, of parents who had distinguished literary and political

connections. Strachey was educated privately and at Trinity College, Cambridge. He began early to publish in literary magazines, and, after his reputation was established, he was a member of the celebrated Bloomsbury group, along with Clive Bell, E. M. Forster, Virginia Woolf, and others. He did not marry and lived with his mother until her death. He himself died on Jan. 21, 1932.

Strachey's literary career was remarkably homogeneous, and it may be said that the book that first brought him to notice, *Eminent Victorians* (1918), set the tone that was to be characteristic of all his later work. It contained studies of Florence Nightingale, Cardinal Manning, and other prominent Victorian persons, the scholarly foundation of the work being concealed by a neat, malicious style which, critics observed, is found more often in psychological or satirical fiction than in ordinary biographical writing. His two full-length studies, *Queen Victoria* (1921) and *Elizabeth and Essex* (1928), established Strachey as a master of his chosen method. *Queen Victoria* and *Eminent Victorians* had a wide popularity for another reason: they attacked an age against which many readers in the 1920's were already in revolt. This attitude and the Strachey technique set a style in biographical writing that tended to degenerate in less skillful hands, the many "debunking" biographies that resulted from this imitation seldom exhibiting the penetration, the wit, the careful choice of detail, and the precision of statement that characterize Strachey's work at its best. H. H. Wa.

**STRADIVARI, ANTONIO** [strɑ′divɑ′ri] (c. 1644-1737), the most celebrated of Italian violinmakers, was born probably in 1644. The exact date and place of his birth are unknown, but the first documentary evidence of his residence in Cremona, the city in which he lived and worked throughout his life, is furnished by one of his violin labels dated 1666. It is this label which also furnishes proof that Stradivari was apprenticed to Nicolò Amati. He died at Cremona, Dec. 18, 1737.

Nearly all of Stradivari's ninety-three years were spent in perfecting his art and in producing the marvelous instruments which were to give his name undying fame. The various periods of his work represent stages in his breaking away from Amati's influence and his search for a type of violin which would afford more breadth of resonance and power of tone. He adhered to the smaller type of instrument until 1684 when he definitely began to turn to larger instruments. His typical "long" pattern measures 14 5/16 in. in length, an increase of 6/16 in. over Amati's pattern. A reduction in the over-all length to about 14 in., with a broadening and arching of the instrument, produced a model of unsurpassable symmetry and beauty. To this later period also belong the finest of his violoncellos.

Stradivari made over a thousand violins, violas, and violoncellos; some six hundred are known to survive. Some of the more famous of the violins are the "Betts," now in the Library of Congress (1704), the "Viotti" (1709), the "Alard" (1715), and the "Messiah" (1716).

Although the Stradivari label is a distinctive one, bearing a Maltese cross and the initials A. S. enclosed within a double circle, there are many thousands of forgeries and imitations containing a reproduction of this label, and only an expert, by personally examining and playing on an instrument bearing a Stradivari label, can say whether it is genuine or false. P. G. G.

**STRADONITZ, FREDRICH AUGUST KEKULE VON.** *See* KEKULE VON STRADONITZ, FREDRICH AUGUST.

**STRAFFORD, EARL OF (THOMAS WENTWORTH)** [stræ′fərd] (1593-1641), English statesman, was born in London, Apr. 13, 1593. Educated at St. John's College, Cambridge, he was admitted to the Inner Temple and during 1612 and 1613 he traveled in Europe. He sat in the parliaments of 1614 and 1621, in the latter giving general support to the policy of King James I. In the parliaments of 1624 and 1625 he showed himself to be against Buckingham's policy of a war with Spain. He made a great enough impression for Charles I to appoint him sheriff in order to keep him out of the Parliament in 1626. It was the King's misfortune not to recognize that Wentworth was an honest critic and not a convinced opponent. In 1627 he was imprisoned for refusing to pay a forced loan which he considered to be illegal; and in the Parliament of 1628 he emerged as one of the leaders of the opposition striving to draw up and obtain the King's consent to the Petition of Right. Throughout Wentworth had been moderate; he had no sympathy with the extreme parliamentarians, who supported Sir John Eliot; he now believed that the King's power had been satisfactorily curbed and that further restrictions would lead to inefficiency in government. Therefore he went over to the King's side, and in December 1628 he was created Viscount Wentworth, and made president of the Council of the North. In 1632 he was appointed Lord Deputy of Ireland and set to work to carry out some much-needed reforms. He got rid of many incompetent officials; he encouraged economic development; and he raised an army paid for by the Irish parliament. His policy of "Thorough" was arbitrary, but aimed at bringing real benefit to a country where conditions had hitherto been chaotic, and where great officials had been tyrannous and corrupt. Wentworth returned to England in September 1639, became the King's chief adviser, and was made Baron Raby and Earl of Strafford in January 1640. On his return from a successful trip to Ireland to enlist aid for the King in England's coming war with Scotland, he found Parliament unwilling to grant the subsidy for the war that the King asked. After Strafford had persuaded Charles to modify his demands, Parliament insisted on peace, Charles reiterated his earlier demands, and Parliament was dissolved. Then the privy council advised that only a defensive war be waged, to which Strafford was diametrically opposed. On the assembling of the Long Parliament in November, Charles ordered Strafford to London, where he was impeached, Parliament being of the opinion that his death was essential to the liberties of the kingdom as part of the constitutional question of the administration leader's responsibility to the nation. Strafford was sent to the Tower on November 25 and executed on May 12, 1641. E. R. A.

**STRAIT OF MAGELLAN.** *See* MAGELLAN, STRAIT OF.

**STRAITS QUESTION,** an issue of international politics concerning the control of the Bosporus, the Sea of Marmara, and the Dardanelles. These Turkish Straits are of great commercial and strategic importance as providing the only means of egress from the Black Sea, and the question of their control is one of the oldest and most continuous problems in European history.

Since the signing of the Treaty of Kuchuk-Kainardji between the Ottoman Empire and Russia, on July 10, 1774, the principle of freedom of passage for merchant ships through the straits has been generally established, and the conventions of 1840, 1841, 1856, 1871, and 1878 still further specified the international character of this waterway. After the defeat of Turkey in World War I, the straits were opened to navi-

gation of every kind and were placed under an international commission until 1922. In 1923, by the Convention of Lausanne, international control was reduced, a portion of Turkish sovereignty was restored, the straits were demilitarized for 30 mi. inland, and a French, English, and Italian surveillance commission was established. This convention was modified in 1936 by the Montreux Convention, effective for twenty years; Turkey was permitted to remilitarize the area and was given complete control over the passage of shipping through the straits in time of war, but otherwise the principle of freedom of passage for merchant vessels was confirmed.

During World War II, Turkey was put under great diplomatic pressure because of the strategic importance of the straits both to Germany and to Western Allies. In 1941 she concluded a treaty of friendship with Germany which isolated the Soviet Union from Allied aid by way of the Black Sea, but Stalin's personal pledge not to occupy the Dardanelles and Allied economic aid and pledges of assistance in case Turkey were attacked prevented Germany from exploiting her diplomatic advantage still further and flanking the Soviet Union on the south through Turkey.

After the war an agreement was reached in Potsdam in 1945 to revise the Montreux Convention, but no immediate action was taken. It was decided, however, that the revision should be based on the principles that the straits should remain open to all merchant vessels and to the warships of Black Sea powers; that, except for a limited tonnage in time of peace, passage through the straits should be denied to the warships of non-Black Sea powers, except with the consent of those powers or except when acting under the authority of the United Nations; and that certain other changes, such as the substitution of the United States for Japan as a signatory, should be made in the Montreux Convention. This plan was accepted by Turkey as a basis for agreement and further discussion. S. C. M.

**STRALSUND** [shtrɑ'lzʊnt], a seaport in the former state of Mecklenburg, in northeast Germany, located 44 mi. northeast of Rostock on the Baltic Sea. The old city occupies a small triangular island joined to the mainland by moles at the angles. Thus it lies on the west coast of Strela Sound, which separates the Baltic island of Rügen from the mainland. Founded in 1209, Stralsund soon became a leading Hanseatic city. In 1628 during the Thirty Years' War, Albrecht von Wallenstein, in the service of the Holy Roman Emperor Ferdinand II, laid siege to the city of Stralsund for eleven weeks before he was forced to withdraw his troops without capturing the city. It belonged to Sweden from 1648 to 1807 and became Prussian in 1815. The town has a distinctly medieval aspect with many houses having high gables toward the streets. Noteworthy edifices, dating partly from the thirteenth century, include the brick Gothic town hall, and the churches of St. Nicholas, St. Mary, and St. James. The city is connected with Rügen Island by a railroad and highway causeway, over which moves rail traffic for Denmark. There is trade in fish, grain, and lumber, and manufactured products include beer, liquors, smoked fish, beet sugar, varnish, playing cards, and boats. Pop. 1939, 52,931. C. C. H.

**STRANGE CASE OF DR. JEKYLL AND MR. HYDE, THE** [jɛ'kɪl], a work of fiction by Robert Louis Stevenson, first published in 1886, which tells a story of the duality of the individual character, of the potentialities for both good and evil in one man. Dr. Henry Jekyll, an eminent London physician known for his upright character, develops a drug which changes him into the deformed, morally hideous, and wholly evil Edward Hyde. As Hyde, he roams the London streets at night, brutally injures a child, and later murders an aged member of Parliament. When the drug fails, after frequent use, to restore him to his better character, he kills himself, leaving with his lawyer, Mr. Utterson, a letter that tells the whole story. J. P. Wo.

**STRAPAROLA, GIOVANNI FRANCESCO** [strɑ'-pɑrɔ'lɑ] (d. c. 1557), Italian author, was born at Caravaggio late in the fifteenth century. The first part of his collection of tales, *Le piacevoli notti* ("The Entertaining Nights"), was published at Venice in 1550, a second part appeared in 1553, and he died sometime after 1557.

Using as the framework of his story the fiction that a company of ladies and gentlemen have gathered to pass the last thirteen nights of carnival listening to songs, stories, and riddles, Straparola relates the seventy-five tales told and the seventy-three riddles propounded. He was markedly original in venturing to introduce into the collection fables and fairy tales in which there are fantastic and supernatural elements, a type of narrative theretofore considered to appeal only to the lowest social classes and not to those who could read and afford books. The story of Puss in Boots, which appears for the first time in European literature in *Le piacevoli notti,* is the most familiar example of this type of tale in Straparola. The majority of his tales, however, deal with the erotic and satirical subjects usual in the collections of the age, and most of these are patent and often unskillful imitations of earlier works.

Extremely popular in sixteenth-century Italy and in France, where it was translated soon after publication, Straparola's work has had a wide influence in the field of the fairy tale. G. R. S.

**STRASBOURG** (*Ger.* **STRASSBURG**) [stra'sbu'r, shtrɑ'sbʊrχ], a river port, industrial center, and fortified frontier garrison, capital of the department of Bas-Rhin in the Alsace-Lorraine region of northeastern France, situated 240 mi. east of Paris. It spreads over a low-lying plain from both banks of the Ill River, just west of its confluence with the Rhine, at the terminus of canals connecting the Rhine with the Marne and the Rhône.

The Romans established on the island in the Ill, which is now the heart of the city, a fortified camp, Argentoratum. This developed as a center of river-boat and wagon traffic, known to the Teutonic tribesmen of the vicinity, the Alemanni, as Strataburgum (city of roads). In 843, when the empire of Charlemagne was divided, the city became part of the realm inherited by Lothaire and in 923 gave its allegiance, along with the rest of the territory ruled by the Dukes of Lorraine, to the German kingdom of the Holy Roman Empire. After a long struggle between the ruling bishop and the citizens, and as a result of the battle of Oberhausbergen in 1262, Strasbourg became a free imperial city. In 1381 Strasbourg joined the Städtebund, the league of Swabian towns. Its reputation as an intellectual center grew, following the development here of printing by Gutenberg in the first half of the fifteenth century and the foundation of a university in 1566. During the French Revolution, although it was here that Rouget de Lisle composed the *Marseillaise,* it was deprived of its rights as a free city because of its pro-German sentiment. The Germans captured it during the Franco-Prussian War, after a bombardment lasting from Aug. 13 to Sept. 27, 1870. Under German rule the city was much enlarged; suburbs were built and a port

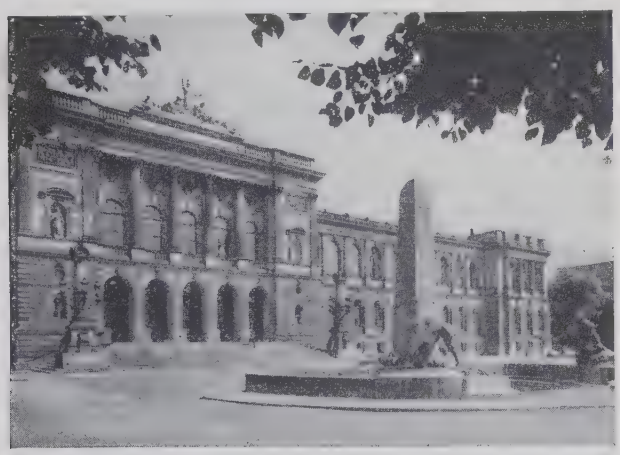
was created. French troops re-entered it on Nov. 22, 1918. Occupied by the Germans again throughout World War II, it was recaptured Nov. 27, 1944, by the French.

The ancient part of the city, on the island embraced by the arms of the Ill, is distinguished for its picturesque old frame houses with steeply peaked roofs and ornamented façades. There are many historic churches dating from the thirteenth and fourteenth centuries. It has been a bishopric since the fourth century.

The port of Strasbourg, first developed by the Germans beginning in 1901 and enlarged by the French since 1918, with its numerous basins, docks, and warehouses, is one of the busiest French ports. The local industries include spinning and weaving, grain milling, brewing, distilling, cabinetmaking, automobile manufacture, tobacco processing, and production of chocolate and bakery goods. An important enterprise is the fattening of geese for the distinctive Strasbourg specialty, *pâté de foie gras*. Pop. 1954, 200,921.

W. McE.

**STRASBOURG, UNIVERSITY OF,** at Strasbourg, France. Its history dates from 1538, when the humanist Johannes Sturm was called by the city of Strasbourg to



YVON

*The University of Strasbourg, founded in 1538, at Strasbourg in northeastern France*

establish a gymnasium by combining three existing high schools. Law, medicine, science, and letters were the first subjects taught. By 1566 this gymnasium had developed into an academy, and in 1621 it became a university with faculties of medicine, science, letters, and theology. Louis XIV confirmed the status of the university in 1697. The university was suppressed during the French Revolution and reopened in 1808. The university was inaugurated as Kaiser Wilhelm Universität on May 1, 1872, after Strasbourg had passed to the Germans at the end of the Franco-Prussian War. Taken by the French again, the university was reorganized and reopened on Nov. 22, 1919. It was removed to Clermont-Ferrand in 1939 at the beginning of World War II, and in 1945 was re-established at Strasbourg.

The university's present faculties teach in the departments of Catholic theology, Protestant theology, law, medicine, science, pharmacy, letters, and political studies. The faculty in 1948 numbered 250 and the student enrollment was 7,128. The library contains approximately 1,500,000 volumes.

A. L. H.-Q.

**STRASBOURG CATHEDRAL,** the Cathedral of Notre Dame in the city of Strasbourg, built of red sandstone, principally in Gothic style, with some Romanesque features. It is noted for its 464-ft. spire, one of the tallest in Europe. Its construction was begun in 1017; but of the present church, only part of the crypt dates to the time of Clovis. The choir, dating from the eleventh and twelfth centuries, is Romanesque; the apse is transitional in style; the nave, reconstructed between 1250 and 1275, is pure French Gothic. The elaborate west façade, celebrated for its wealth of sculpture, was begun in 1270; the tracery spire, which rises from the northern tower, designed by Johann and Jean Hültz of Cologne, was completed in 1439. Its magnificent rose window, 50 ft. in diameter, was designed by Erwin von Steinbach. This and the other windows are notable for their screens of double tracery. On the Romanesque south portal are fine sculptures. The interior is notable for its richly sculptured pulpit, dating from 1486, and for its stained glass.

W. McE.

**STRASSBURG.** *See* STRASBOURG.

**STRATEGY, MILITARY.** *See* MILITARY STRATEGY AND TACTICS.

**STRATFORD,** a city and the county town of Perth Co., Ontario, Canada, on the Avon River, 80 mi. west of Toronto, and 105 mi. northwest of Buffalo, N.Y. It is on Provincial Highways 7 and 8, and is an important divisional point for the Canadian National Railways. Surveyed by the Canada Company in 1834, it became a town in 1858 and was incorporated as a city in 1884. Its early development was as a supply center for Perth County, but in 1870 it obtained its first large-scale industry in the form of the railway shops, which continue to be a leading activity. Furniture factories, textile mills, packing plants, iron and brass foundries, flour mills, and dairy plants are important. A provincial normal school is located there. During World War II it was the site of a training camp for a Netherlands fighting force. Pop. 1951, 18,785.

D. F. P.

**STRATFORD,** a town and summer resort in southwestern Connecticut, situated in Fairfield Co., 3½ mi. east of Bridgeport, on Long Island Sound, at the mouth of the Housatonic River, in a general farming area. Stratford was founded in 1639 and was named after the English town Stratford-on-Avon. The government of the town is the council-manager type. Stratford in its early days was renowned for its shipbuilding and its oyster fisheries. A feature of historic interest is the David Judson House, built in 1723. Transportation is provided by the New York, New Haven and Hartford Railroad. Although Stratford is primarily a residential town, there are local manufactures of aircraft, machinery, brake linings, roofing, and hardware. Pop. 1950, 33,428.

**STRATFORD-ON-AVON,** a municipal borough in Warwickshire, England, situated on the west bank of the Avon River, 85 mi. northwest of London. It is famous as the birthplace and residence of William Shakespeare. Relics indicate that it was probably inhabited by Celtic tribes and later by Romans and Saxons. It received its first charter from Edward VI in 1553; others were granted in 1611, 1664, and 1674. The house where Shakespeare was born has been national property since 1847. It is a one-story, gabled, wooden structure, originally divided into two sections, the west part, which was the dwelling, and the east part, which was the workshop of John Shakespeare, William's father. A room in the west part has been indicated as the birthplace of the poet, although there is no evidence to substantiate the claim. New Place, bought by Shakespeare in 1597 and after his death

the residence of Thomas Nash and his wife, Shakespeare's granddaughter, was torn down in 1759. Its site was purchased by popular subscription in 1876. Shakespeare and his wife, Anne Hathaway, are buried near the chancel of Trinity Church. Of additional interest are Guild Hall, nearby, where the poet attended grammar school, his mother's cottage at Wilmcote, and Anne Hathaway's cottage at Shottery, a mile away. The Harvard House, built in 1596, and the home of the mother of John Harvard, was presented to Harvard University in 1909 by Mrs. Edward Morris. The sixteenth-century appearance of the town has been restored to represent Stratford-on-Avon as Shakespeare knew it. The older Shakespeare Memorial Theatre, built in 1877, was burned in 1926, and the new Memorial Theatre, built by popular subscription, was opened in 1932. The majority of the plays presented during the annual theatrical season in the Memorial Theatre are those written by the famous bard. The community is one of the most popular tourist spots in England. Agricultural trade and brewing comprise the principal industries. Pop. 1952, 14,610. A. W.

**STRATHCONA AND MOUNT ROYAL, BARON.** *See* SMITH, DONALD ALEXANDER.

**STRATHROY** [strathrɔi′], a town in Middlesex Co., Ontario, Canada, 22 mi. west of London, on the Canadian National Railways and Provincial Highway 22. Incorporated as a town in 1871, it is in the center of a fertile agricultural area, noted for its purebred cattle, registered seed grain, nursery stock, and tobacco farming. Textiles and furniture are manufactured in the town. Pop. 1951, 3,708. D. F. P.

**STRATHSPEY** [strathspe′; stra′thspe], a Scottish folk dance in duple meter, the name deriving from the "strath," or valley, of the Spey River in the north of Scotland. The strathspey is related to the reel but it is somewhat slower, its music preferring dotted notes and a "Scotch snap," and while the reel is a gliding dance, the strathspey is rather jerky. Niel Gow (1727-1807) was the most distinguished composer and performer of reels and strathspeys. P. N.

**STRATOSPHERE.** *See* METEOROLOGY.

**STRAUS, OSKAR** [shtrau′s] (1870-1954), Austrian operetta composer, was born in Vienna, Apr. 6, 1870. He studied composition in Vienna with Hermann Grädener and in Berlin with Max Bruch. From 1895 to 1900 he was conductor and composer for the Wolzogenschen Überbrettl in Berlin. *Der tapfere Soldat* (*The Chocolate Soldier*) (1908), based on George Bernard Shaw's comedy *Arms and the Man,* was his most famous operetta, and *My Hero,* the principal soprano song from its score, became one of the most popular songs in the semipopular repertory. *The Waltz Dream,* the title song from the operetta *Ein Walzertraum* (1907), is also very frequently played, usually as an instrumental number. Straus also wrote chamber music. He left Berlin in 1927 and afterwards lived in Paris and the United States, becoming a French citizen in 1939. In addition to many operettas, he has written music for two of Maurice Chevalier's motion pictures, *The Smiling Lieutenant* (based on *Ein Walzertraum*) and *One Hour with You.* None of his later operettas had the success of his earlier works. He died in Bad Ischl, Austria, on Jan. 11, 1954. F. G. P.

**STRAUSS** [shtrau′s], the name of a Viennese musical family, composers of Viennese waltzes and light opera.

**Johann, Sr.** Johann Strauss, Sr. (1804-1849), was one of the most popular writers and performers of light music of his time. It was due to him that Vienna was first considered all over the world as the home of lighter music. He originally played the viola in the quartet of the waltz-composer Josef Lanner, but at the age of twenty-two he founded his own orchestra, which eventually became so successful that he was invited to play at the coronation of Queen Victoria. Among his 251 compositions the best known are the waltzes *Donaulieder* ("Songs from the Danube") and *Das Leben ein Tanz* ("Life is a Dance"). Strauss the elder had three gifted sons.

**Johann, Jr.** Johann Strauss, Jr. (1825-1899), the eldest son, composer of dance music and operetta, was born in Vienna, Oct. 25, 1825. At the wish of his father, he was to become a bank clerk; but he soon won fame both as the conductor of a dance orchestra and as a composer. He was acclaimed as an orchestra leader in Vienna, St. Petersburg, Paris, London, and also in New York and Boston. His waltzes and quadrilles were considered the truest expression of the tenderness, grace, and charm of the Viennese soul, while his operettas rivaled in success those of Alexandre Lecocq and Jacques Offenbach. Strauss had at his disposal inexhaustible sources of melodic invention; he also used interesting harmonies and a fascinating style of orchestration. Such diverse musicians as Arthur Nikisch, Hans von Bülow, Ruggiero Leoncavallo, Johannes Brahms, and Richard Wagner were his ardent admirers. Among his almost five hundred waltzes, *An der schönen blauen Donau* ("The Beautiful Blue Danube") achieved the greatest popularity, being regarded the world over as a sort of joyous and brilliant anthem of Vienna. Almost equally successful were the *G'schichten aus dem Wiener Wald* ("Tales from the Vienna Woods") and *Frühlingsstimmen* ("Voices of Spring"). In Strauss's operettas we find French wit with a definitely Viennese touch, and an unusually artistic interweaving of themes. *Der Zigeunerbaron* ("The Gypsy-Baron") and *Die Fledermaus* ("The Bat") won world fame.

**Josef.** Josef Strauss (1827-1870), the second son, became an architect, owing to the prejudice of his father, who did not want any of his children to become musicians. But his urge to compose was too strong. He formed his own orchestra, for which he wrote no less than 283 pieces of dance music, among them a number of charming mazurkas of an almost Schubertian grace. The full extent of Joseph's talent was discovered only in the twentieth century, when a number of operettas (among them *Frühlingsluft*) using his melodies were performed.

**Eduard.** Eduard Strauss (1835-1916), the youngest son, composed 318 dance pieces, but he was known mainly as the successful interpreter of the dances of the older members of the family. He wrote a book of *Memoirs* (1906), containing valuable biographical material about the whole dynasty. K. G.

**STRAUSS, DAVID FRIEDRICH** (1808-1874), German theologian and writer, was born in Ludwigsburg, near Stuttgart, Jan. 27, 1808. After preparatory study in the seminary at Blaubeuren, he entered the University of Tübingen in 1825, where he came to be profoundly influenced by Hegel and somewhat less by Schleiermacher.

On his return to Tübingen, Strauss was granted the privilege of a *Repetent* tutor, in the University, while he prepared himself to become a member of the faculty of philosophy. Meantime he devoted himself to the completion of a work he had already planned in Berlin and in 1835-1836

published his two-volume *Leben Jesu kritisch bearbeitet;* this appeared in a three-volume English translation, *The Life of Jesus, Critically Examined,* in 1846. Strauss was only twenty-nine years old when he finished the German edition. The conclusion of the second volume contains a speculative Christology which contradicts both the supernaturalistic and the rationalistic conception of Christ and Christology.

Strauss's thought was distinguished by what has become known as the Mythical Theory, or the key to the true meaning of the Gospels and Epistles of the New Testament and even of the prophecies of the Old Testament. By this device he intended to escape both the literalism of the supernaturalists (orthodoxy) and the humanism of the rationalists, who regarded the supernatural facts in the New Testament as mere human inventions and surrendered the divine contents of the Bible. According to Strauss's conception of a myth, it has an element of historical fact around which are woven the religious feelings and ideas of groups of persons at a particular time and place. But these ideas, he argues, are not based on actual historical data, and the infancy narratives in Matthew and Luke, the miracles, the resurrection, and the glorification of Jesus he therefore considers to have no basis in historical fact. To Strauss a myth was a legitimate literary form for the expression of truth which the historian, the philosopher, or the scientist could not present in prosaic form. To use his own words: "Myth is the creation of fact out of an idea; legend is seeing an idea in a fact."

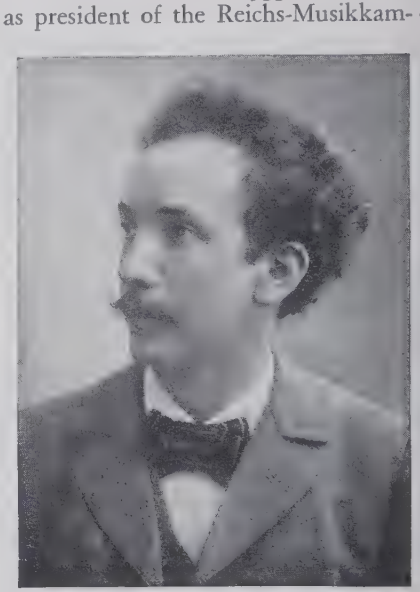
The *Leben Jesu* created a sensation throughout Europe and called forth numerous books and tracts, some of them criticizing and denouncing its author as anti-Christ. Strauss was compelled to leave Tübingen, but was invited to a professorship in the University of Zürich, which, on account of the vigorous protests of clergy and laity, he never accepted. He then retired into private life and lived in Ludwigshafen, Munich, Weimar, Heidelberg, and Darmstadt. He died in Ludwigsburg on Feb. 8, 1874.

Strauss continued to write notable books and did not recant the Mythical Theory. Among these books were *Die Christlichen Glaubenslehre in ihrer geschichtliche Entwicklung und im Kampfe mit der modernen Wissenschaft dargestellt* (1840-1841) ("The Christian Doctrine of Faith in its Historical Development and in its Controversy with Modern Science") and *Das Leben Jesu für das deutsche Volk* (1864) ("The Life of Jesus for the German Nation"), in which he renounced the Church and its creeds. His last work was *Der alte und der neue Glaube* (1872) ("The Old Faith and the New," 1873), and he also wrote a very readable biography on Voltaire, which has not been translated into English. Strauss was a master of German prose, and even his bitterest opponents regarded him as a brilliant writer and a lover of truth.

G. W. R.

**STRAUSS, RICHARD** (1864-1949), German composer, was born in Munich on June 11, 1864. His father, Franz Strauss, was a horn player in the court orchestra, and consequently the boy's musical training started early. When he was still only twenty, his First Symphony in F minor, Op.12, was performed in New York under Theodore Thomas. His early compositions were conventional, and cast in strictly classical forms, but on one of his first conducting jobs, in Meiningen during the season of 1885-1886, he came under the influence of Alexander Ritter. Ritter changed his attitude toward the "advanced" composers of the day, Franz Liszt and Richard Wagner, and Strauss's style underwent such a radical change that for the decades before and after 1900 he and Claude Debussy (born in 1862) were rated as the world's foremost exponents of program music.

In addition to his composing, Strauss built up an enviable reputation as a conductor. He was in much demand all over Europe as a guest conductor, even making two trips to the United States in 1904 and 1922. His principal conductorial jobs, however, were with the Royal Opera in Berlin from 1898 to 1918, and as co-director with Franz Schalk of the Vienna State Opera from 1919 to 1924. Although he was ostensibly in retirement, the National Socialists called him to Berlin in November 1933, and, until June 1935, he served as president of the Reichs-Musikkammer. It has been rumored that his relations with the Party grew cooler with the passing years, but nonetheless he was commissioned to write in 1941 the *Festmusik zur Feier des 2600 jährigen Bestehens des Kaiserlichen Japan,* Op.84, as a gesture of friendship between Germany and Japan. Strauss died at Garmisch-Partenkirchen on Sept. 8, 1949.



*RICHARD STRAUSS*

CULVER SERVICE

Although he has composed works in almost every genre, Strauss is chiefly famous for his songs, tone poems, and operas. Numerically, the songs predominate, with groups of them, either with piano or orchestral accompaniments, published under more than thirty opus numbers. The earlier ones, such as *Zueignung* and *Allerseelen* (from Op.10), *Ständchen* (from Op.17), *Heimliche Aufforderung* and *Morgen* (from Op.27), and *Traum durch die Dämmerung* (from Op.29), are in the best tradition of the German *Lied.* The later songs, however, seem more contrived, and have not won the same spontaneous appreciation.

Among his tone poems, *Aus Italien,* Op.16, is a transitional work, written while he was changing from the classical to the programmatic style. *Don Juan,* Op.20 (performed 1889), was his first great success in the form of the symphonic poem, and with the impudent *Till Eulenspiegels lustige Streiche,* Op.28 (1895), it remains one of his most popular works. *Macbeth,* Op.23 (1890), is rarely heard today, but the dramatic climax of *Tod und Verklärung,* Op.24 (1891), has kept it in the regular repertoire of most orchestras. His later symphonic poems—*Also sprach Zarathustra,* Op.30 (1896), *Don Quichote,* Op.35 (1897), *Ein Heldenleben,* Op.40 (1898), *Sinfonia domestica,* Op.53 (1904), and the *Alpensinfonie,* Op.64 (1915)—produced great clamor and excitement when they first appeared, and several of them remained standard repertory pieces for several decades. By the mid-twentieth century they began to sound over-long,

meandering, and formless, since Strauss almost certainly stretched the binding power of a program too far.

When bolstered with a good text, Strauss's shrewd planning of dramatic effects made him pre-eminent as an opera composer, and three or four of his works in this field are among the best operas of the past half century. His first two, *Guntram* (1894) and *Feuersnot* (1901), were considered "too Wagnerian," complicated, and gloomy, but with *Salome* (1905), set to a translation of Oscar Wilde's play, he startled the whole world. In *Elektra* (1909), he tried to achieve even greater brutality of treatment. A sudden change of pace comes with *Der Rosenkavalier* (1911), with its lovely waltzes, brilliant orchestration, and general spirit of genial sophistication. Most critics feel that altogether it is Strauss's most satisfactory work. The revision (1916) of *Ariadne auf Naxos,* originally performed in 1912, won favorable critiques in 1947, but with the exception of *Arabella* (1933), which is very popular in the provincial opera houses in Germany, the long line of later operas is rarely performed, and needs only be listed for the record: *Die Frau ohne Schatten* (1919), *Intermezzo* (1925), *Die Aegyptische Helena* (1928), *Die schweigsame Frau* (1925), *Der Friedenstag* (1938), *Daphne* (1938), *Capriccio* (1942), and *Die Liebe der Danae* (1944).

R. S. H.

**STRAVINSKY, IGOR** [strʌvyi'nskɜɪ] (1882- ), a leading modern composer, was born in Oranienbaum, near St. Petersburg, Russia, June 17, 1882. His father was an opera singer, and Stravinsky was brought up in a musical environment. Beginning to compose without the aid of formal instruction, he was already in his twenties when he took his first lessons with Rimsky-Korsakov. His first published work, a symphony (1905), is academic in character. Under the influence of Rimsky-Korsakov, Stravinsky became interested in Russian musical folklore. His first important work of Russian national character came in 1910 as a result of his meeting with Diaghilev, the famous Russian ballet impresario, who was then planning a series of performances of Russian ballet in Paris. Stravinsky wrote for him one of his most brilliant orchestral scores, *The Firebird* (1910), based on a Russian fairy tale. The following year Stravinsky composed another ballet, *Petrushka,* in which he depicted with vivid and authentic imagery the Russian carnival scenes. The musical language of *The Firebird* and *Petrushka* still retains a connecting link with earlier musical tradition. With the creation of his third ballet score, *Le Sacre du printemps* (1913), representing scenes of ancient pagan Russia, Stravinsky broke with the musical past. In this work he makes free use of unresolved dissonances and employs constantly changing rhythms of unheard-of complexity. The score is written for a huge orchestra, and the technical demands upon the players are extreme. The first performance of *Le Sacre du printemps* by Diaghilev's ballet in Paris, May 29, 1913, was marked by violent demonstrations on the part of the audience, and Stravinsky's name became symbolic of ultra-modern trends in music.

Before the outbreak of World War I Stravinsky left Russia. He lived in France until 1939, when he settled in America, becoming an American citizen Dec. 28, 1945. This voluntary expatriation resulted in a gradual abandonment of Russian folklore in Stravinsky's music. Russian motives are still present in his score for seven instruments, *History of a Soldier,* written during World War I, and in *Les Noces* (1920), a stylization of a Russian village wedding, scored for voices, four pianos, and seventeen percussion instruments. His later works reveal a tendency toward classical and religious music. To this category belong his Piano Concerto (1924), the ballet *Apollon musagètes* (1927), and particularly the modern cantata, *A Symphony of Psalms* (1930). During the same period Stravinsky wrote musical scores based on themes of Pergolesi (*Pulcinella,* 1920) and Tchaikovsky (the ballet *Baiser de la fée*). The score of his *Symphony in Three Movements* (1945) is a synthesis of his neoclassical manner and the revolutionary style of the period of *Le Sacre du printemps.*

The influence of Stravinsky on contemporary music is very great. National composers in countries as widely separated as Spain, England, and the United States have experienced at one time or another the powerful impact of Stravinsky's music, either in its neoprimitive Russian manner or in the later neoclassical style. Young composers in America, especially, have eagerly followed the new paths opened by Stravinsky's novel use of classical techniques. N. Sl.

**STRAWBERRY,** the common name for the so-called fruit of the genus *Fragaria* of the rose family, with about 20 species, all low perennial herbs, native to the North Temperate Zone and to high altitudes of tropical South America.

THOMÉ - DR. LASCOFF

*A wild strawberry plant of the genus Fragaria, showing leaf, flower, fruit, and seed*

Strawberries have long been grown for the highly prized, delicious fruits, which are in reality juicy, fleshy red receptacles, which bear imbedded on their surface the small, seedlike true fruits. The plants send out long slender runners which root to produce new plants. The trifoliate leaves and the flower stalks with their clusters of white or reddish flowers rise from a low crown. Strawberries have been cultivated in Europe for at least 500 years. The Virginia strawberry, *Fragaria virginiana,* was introduced into England in 1629, and the Chile strawberry, *F. chiloensis,* into France in 1715. When North America was first settled, the wild strawberries were so plentiful that there was no garden culture of the fruit until about 1770. Commercial strawberry growing began about 1800, near the largest cities; strawberries are now a leading small fruit in the United States, their culture extending from Florida to Alaska.

The strawberries most commonly grown are derived from three main species. The Chilean strawberry grows near the coast from Alaska to Patagonia. The flowers and fruits

are hidden under the leaves, and the seeds sunk in pits on the receptacles. A form, the pine strawberry, var. *ananassa,* considered a species or hybrid by some botanists, is believed to be the parent of most garden varieties. The European strawberry, *F. vesca,* native to the Old World and northern North America, has flowers and fruit borne above the foliage and the seeds on the surface of the fruits. It is the source of European Alpine strawberries, some of the everbearing varieties, and various white fruited forms. The Virginia strawberry, widespread in North America, and the common wild strawberry of the eastern part, resembles the Chile strawberry and may be with it a parent of the pine strawberry. It has also been used as a more recent parent of modern varieties.

**Cultivation.** Strawberry plantations are made from the runners produced by old plants. In home gardens, well rooted runners can be set out in late summer and early fall and with good care and favorable conditions will bear well the following summer. In the South, commercial plantings made in late summer give a winter crop. In the North, commercial plantings are made in early spring. The first year, the plants and runners produced by them are well cared for to give a fine crop the following year. Well-cared-for plantings will produce for five or six years, but it is the usual commercial practice to have new beds coming along and to plow up the old ones after one cropping. There are several methods of growing these plants. In the matted row system, widely used commercially, all plants and their runners are allowed to grow. In the hedge row system, the runners spreading beyond a strip 12 to 18 in. are cut off. The hill system is used to produce the highest quality of strawberry. Here no runners are allowed to develop. Strawberries require a well-drained, fertile, moist soil, and thrive in cool weather. Only young plants that have not borne should be planted. When only a few are needed, runners can be made to root in pots of soil sunk in the ground near parent plants. When they have rooted well, the young plants can be placed in the new location. The crowns must be set just above soil level; if too deep, they will rot, if too shallow the roots will dry out. In the North, the plants should be well mulched to prevent heaving.

**Varieties.** Varieties of strawberries are adapted to certain small areas. Among those that thrive in the east and middlewest are: Howard, Clermont, Dresden, Culver, Catskill, Fairfax, and Chesapeake; in Florida and the Gulf States are Klondike, Missionary, and Aroma. Varieties grown on the Pacific Coast are: Clark, Dollar, Magoon, Marshall, and Oregon. Home fruit growers usually like to have a few fall bearing varieties of which the best are: Rockhill, Mastodon, and Gem. E. L. Sh.

**STRAWBERRY BASS.** *See* CRAPPIE, CALICO BASS, or STRAWBERRY BASS.

**STRAWBERRY GERANIUM,** a hairy perennial, *Saxifraga sarmentosa,* of the saxifrage family, native to China and Japan. It resembles the strawberry in its running habit of growth. In mild regions, it is cultivated as a garden ornamental, and in the North as a house plant, or under glass. The long-stalked, rounded leaves, white-veined above and reddish below, lie close to the ground; but the slender, erect flower stalks are sometimes 2 ft. high and bear open clusters of delicate, pinkish-white flowers. J. C. Wis.

**STRAWBERRY GUAVA** [gwɑ′və], a Brazilian shrub or tree, *Psidium cattleianum,* growing to about 25 ft. tall, of the myrtle family, closely allied to the common guava, and cultivated in California, Florida, and other warm regions for its edible fruit. It has smooth, dark green, leathery, rather oblong leaves, and large, white, solitary flowers. The sweet, aromatic fruit, 1 to 1½ in. long, is roundish, with thin, purple-red skin and soft, whitish flesh containing numerous hard seeds; it tastes somewhat like a strawberry. J. C. Wis.

**STRAWBERRY TREE,** a handsome evergreen tree, *Arbutus unedo,* of the heath family, which is widely grown for ornament in mild climates. In autumn, it bears nodding clusters of white or rose-colored flowers which are followed by showy fruits, scarlet in color and berrylike in shape. The glossy green leaves are oblong, and the tree usually grows 10 to 15 ft. high in cultivation. It is a native of the Mediterranean region, and is closely allied to the madroña. The name is also applied to various species of spindle tree, *Euonymus. See also* EUONYMUS. J. C. Wis.

**STRAW CAT.** *See* PAMPAS CAT.

**STREATOR** [stri′tər], a city in La Salle Co., in northern Illinois, located 48 mi. northeast of Peoria, on the Vermilion River. Coal and shale are found in the vicinity. The city, founded in 1868 and known first as Hard Scrabble and Unionville, was incorporated in 1882. It is governed by a commission. Transportation for this industrial community is supplied by the Atchison, Topeka and Santa Fe, the Wabash, the New York Central, the Chicago, Burlington & Quincy, the Gulf, Mobile and Ohio railroads. There are railroad shops in the city, and the factory output includes glass bottles, furniture, brick, tile, farm implements, truck bodies, and foundry products. Pop. 1950, 16,469.

**STREETCARS, ELECTRIC.** Electric streetcars for city passenger transportation, introduced about 1884, had iron underframes, supported by two axles with rigidly mounted wheels driven by electric motors through spur gears. A body was mounted on the frame, its length being limited to about 20 ft. by the rigid wheelbase. Early in the twentieth century, a car with two swiveling trucks succeeded it, permitting the car to go around sharp curves and making greater length. City cars are as much as 50 ft. in over-all length and seat up to sixty persons.

Practically all streetcars built in the United States since 1935 are of the type designed under the supervision of the Electric Railway Presidents' Conference Committee (P.C.C.). The cars embody results of extensive experiments in mechanical performance, noise reduction, comfort, heating, and ventilation. Body framing is of pressed steel with roof, sides, and underframe welded to form one structure. The body is mounted on double trucks in which rubber is inserted at all moving joints, replacing steel springs. Wheels have rolled steel treads, separated from the hubs by annular rubber disks.

Four 55-hp. motors, one geared flexibly to each axle by hypoid gearing with a speed reduction of approximately 7 to 1, drive the car at speeds up to 45 m.p.h. Control is rheostatic, starting being governed by insertion of resistance in series with the motors. Highest speeds are obtained by field weakening. Relays protect the equipment and assure smooth acceleration of 3 to 4 miles per hour, per second. The main controller, placed under the car, is actuated by a pedal as in an automobile.

Braking is a combination of dynamic and pneumatic in the older P.C.C. cars, and all-electric since the 1946 model. A supplementary solenoid track brake, taking current directly

from the trolley, consists of shoes mounted between the wheels, the shoes being pulled toward the rails magnetically. Early P.C.C. cars completed the stop below about 5 m.p.h. (the lower limit of dynamic braking) with air brakes, the shoes pressing against the wheel treads as in railroad practice, and being controlled by the same pedal as the dynamic brake. Starting with the 1946-model car, dynamic braking was carried to less than 1 m.p.h. The air brakes have been replaced by drum brakes on the motor shaft, which are applied by springs and released by solenoids. No hand brake is necessary.

Forced ventilation is used on all P.C.C. cars. Air drawn through ducts leading from the roof is passed into a chamber under the car where waste heat from the control resistors, and electric heat directly from the trolley wire, warm it in winter. It then is distributed in ducts to the car interior. In early designs of the car some 1,200 to 1,500 cu. ft. of air per minute circulated, whereas in the 1946 design the rate is 12,000 to 14,000 cu. ft. per minute. A motor-generator-blower unit adjacent to the air chamber circulates the air and forces it through the motors and resistors. It also supplies 32-volt current for charging a storage battery that furnishes power for control and auxiliary equipment.

Weight of the standard car is 36,000 lb., of which approximately 17,200 lb. is in the body, the remainder consisting of trucks, motors, and electrical equipment. *See also* ELECTRIC TRACTION; TROLLEY BUSES. M. Bu.

**STREITBERG, WILHELM AUGUST** [shtrai'tbɛrχ] (1864-1925), German linguist, was born at Rüdesheim, in the Rhineland, Feb. 23, 1864. After teaching at Freiburg in Switzerland, and at Leipzig, Münster, and Munich, he succeeded Karl Brugmann at Leipzig in 1920. He was one of the leading linguists of his generation, his main fields being the Germanic languages and Indo-European.

Streitberg's *Urgermanische Grammatik* (1896) presents, in admirably condensed form, the essential results of the investigations that had at that time been made into the structure of Primitive Germanic. His *Gotische Bibel* (1908-1910), a monumental work, presents an excellent historical grammar of Gothic, all the Gothic texts critically analyzed, and the Greek text from which the Gothic was translated. Streitberg also investigated the difficult problem of the Indo-European vocalic alternations (*Die Entstehung der Dehnstufe,* 1894) and its relationship to the accent, in a work that is still fundamental. He founded, with Brugmann, the *Indogermanische Forschungen* (1891), for a long time the main linguistic journal of the world, and directed it alone at Brugmann's death in 1919; he also published alone, from its inception, the excellent bibliographical and critical supplement (*Indogermanischer Anzeiger*). Streitberg instituted the famous *Germanische Bibliothek* in 1896, founded the *Indogermanische Gesellschaft* in 1912, and directed that society's *Indogermanisches Jahrbuch* with A. Thumb and later with A. Walde. Before his death he also completed the first part of a work, posthumously published, entitled *Germanisch*. Streitberg died in Leipzig on Aug. 19, 1925. G. B.

**STRENGTH OF MATERIALS,** the branch of applied mechanics that treats of stresses and deformations resulting from forces acting on solid bodies. Other names for this branch of mechanics are mechanics of materials and mechanics of elastic bodies.

Stress in a body due to applied loads is the force per unit of area (pounds on each square inch) that one part of the body exerts on an adjacent part. Deformations of a body resulting from applied loads are the changes in the dimensions or size and shape of the body. Strength of materials investigates the relationships between loads, stresses, and deformations in two ways: (1) by the mathematical derivation of formulas expressing relationships between loads and resulting stresses and deformations; and (2) by experimental methods including testing of materials used in structures and machines to determine the properties of such materials. The relationships derived analytically and the data found by testing are used to determine the necessary sizes of members in structures and machines that support given loads. Strength of materials is not an exact science because many relationships employed are based on assumptions concerning the behavior of materials that are not exactly true. Nevertheless, it furnishes satisfactory tools with which competent designers achieve safe and economical structures.

Some knowledge of strength of materials existed when the ancient Greeks and Romans built their large structures, but the modern science began at the time of Galileo Galilei, whose researches led to faulty results but who was the first of a succession of mathematicians, physicists, and engineers to contribute to the science. In the past, much of the science was developed in universities and engineering schools. Currently, progress is being made by research in engineering schools, and in commercial, industrial, and government-supported laboratories such as those of the Bureau of Standards and the Forest Products Laboratory. Special committees of the national engineering societies also make notable contributions.

Closely allied to strength of materials is the mathematical theory of elasticity, a science also concerned with stress and deformation. Through use of the theory of elasticity, problems may be solved that do not yield readily to the usual methods of strength of materials. There is no well-defined boundary between advanced strength of materials and the mathematical theory of elasticity. Most of the problems of stress variation have been solved by mathematical analysis, but in cases involving very complicated conditions the mathematical solutions may become extremely laborious or even impossible. Ingenious experimental methods of stress analysis have been devised that have been successfully applied to such cases. The Society for Experimental Stress Analysis, organized in 1943, serves as a medium for the exchange of knowledge of such methods.

## STRESS AND DEFORMATION

**Types of Stresses.** The most important concept in strength of materials is that of unit stress or intensity of stress. Stresses are of three kinds: tensile, compressive, and shearing.

If a load is suspended by a metal bar, as shown in Fig. 1, the bar is said to be a tension member. If the load weighs 10,000 lb., the tension in the bar is 10,000 lb. If the bar is 2 in. wide and 1 in. thick, and thus has a cross-sectional area of 2 sq. in., the stress intensity or tensile unit stress is 5,000 lb. per sq. in. When the unit stress is uniform over the cross section, as in this example, the unit stress $S$, caused by a load $P$ on a tension member having a cross section of $A$ square inches, is given by the formula $S = P/A$. A body while stressed in tension is longer than when unstressed.

If a short prism (Fig. 2) rests on a floor and a load is placed on its upper end, and is supported by it, there is compressive stress on all cross sections of the prism. If this stress is uniform over the cross section, the unit stress $S$ is given by the formula $S = P/A$. A prism stressed in compression is shorter than when unstressed.

An illustration of shearing stress is provided by the bolt shown in Fig. 3*a* which holds the upper end of the tension member *AB* in Fig. 1. The bolt supports the bar by exerting an upward force of 10,000 lb. on the part of the bar just above the hole in the bar, and the bar, in turn, bears down on the middle section of the bolt with a force of 10,000 lb.

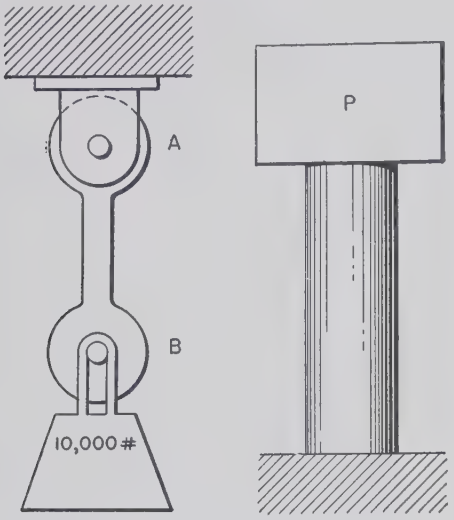



*Fig. 1* (LEFT)—*ILLUSTRATION OF A TENSION MEMBER; Fig. 2* (RIGHT)—*ILLUSTRATION OF A COMPRESSION MEMBER*

The forces on the bolt are applied as shown in Fig. 3*b*. If the bolt were made of a material of low shearing strength, such as lead, it would be sheared off on two vertical planes as shown in Fig. 3*c*. If the bolt is of steel and of sufficient diameter, it will not fail but there will be shearing stress on each of two vertical cross sections. When shearing stress is uniformly distributed its value is given by $S_s = P/A$. The total shearing force on each of the two cross sections of the bolt is 5,000 lb., and if the bolt is 1 in. in diameter (cross-sectional area 0.785 sq. in.), the unit shearing stress is $S_s = 5{,}000/0.785 = 6{,}370$ lb. per sq. in.

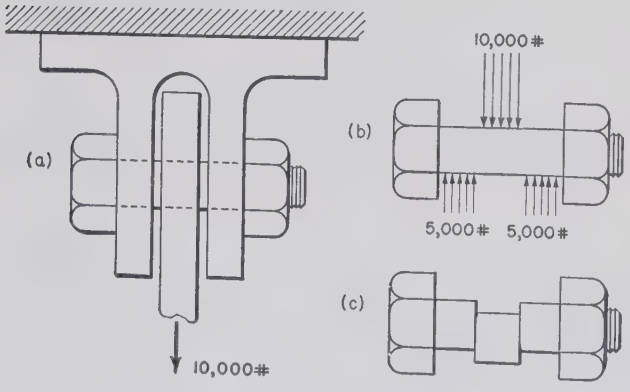



*Fig. 3—ILLUSTRATION OF SHEARING STRESS IN A BOLT*

It should be noted that, in tensile and compressive stresses, the planes on which the stresses occur are perpendicular to the direction of the stresses, but, in shearing stress, the planes on which shearing stresses act are parallel to the stresses. Because of this distinction, tensile and compressive stresses are called normal stresses, and shearing stress is called tangential stress.

**Deformation or Strain.** In a body to which loads are applied, changes in dimensions caused by the loads are called deformations or strains. Deformation that occurs in a unit length is called unit deformation. If every inch of length changes the same amount, the unit deformation is uniform. The symbol $\delta$ is often used for unit deformation and $\Delta$ for total deformation. If the unit deformation throughout a length $L$ is constant, then $\delta = \Delta/L$. For example, if a bar of steel 80 in. long before a tensile load is applied is 80.06 in. long when loaded, total deformation $\Delta$ is 0.06 in. and the unit deformation $\delta = 0.06/80. = 0.00075$ inches per inch.

For nearly all materials used in structures and machines, unit deformation is proportional to unit stress, provided that unit stress does not exceed a value called the proportional limit. This very important relationship is known as Hooke's Law. It was discovered experimentally and stated by Robert Hooke, an English clockmaker, in 1678. The relationship between stress and deformation for any material is given by the formula $S = E\,\delta$, in which $E$ is a constant for a material. Physicists call this constant Young's Modulus, after Thomas Young, who defined it in 1802; engineers call it the modulus of elasticity. Steel has the highest modulus of elasticity of all common engineering materials, the value being about 30,000,000 lb. per sq. in. In a bar of steel, a unit deformation of 0.00075 in. per in., as in the example above, would be caused by a unit stress $S = E\delta = 30{,}000{,}000 \times 0.00075 = 22{,}500$ lb. per sq. in., a stress well within the proportional limit. If, on the other hand, the bar were of aluminum with a modulus of elasticity of 10,000,000 lb. per sq. in., a stress of only 7,500 lb. per sq. in. would cause the same deformation of .00075 in. per inch. It is thus evident that the elastic

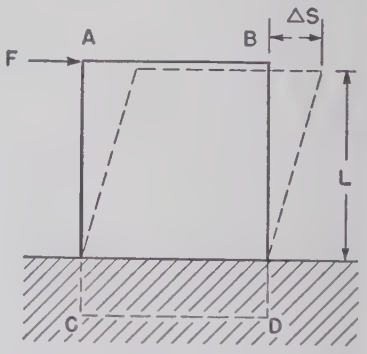



*Fig. 4—VISUALIZATION OF SHEARING DEFORMATION*

deformations that occur in structures and machines are very small. Even with the relatively high unit stress of 22,500 lb. per sq. in. in the above example, the deformation of the steel bar is less than one-thousandth of the length. A steel member 30 ft. long would lengthen about one-quarter of an inch when stressed to a rather high tensile unit stress. This great stiffness of steel is a valuable quality.

Shearing deformation is less easily visualized than is tensile deformation or compressive deformation. As an example, consider a rectangular prism *ABCD* (Fig. 4). The lower end is shown as tightly embedded in some rigid body. If a horizontal force of $F$ pounds is applied to the upper end of the prism, shearing deformations will result as indicated by the dotted lines. The displacement $\Delta$ is the total shearing deformation that occurs in the length $L$. Unit shearing deformation is given by the formula $\delta = \Delta/L$. Hooke's Law also holds for shearing deformations, provided that the shearing unit stress does not exceed the shearing proportional limit. Consequently, $S_s = E_s\,\delta$, in which $E_s$ is the shearing modulus of elasticity, often called the modulus of rigidity. For any material, $E_s$ is less than $E$. For steel, $E_s$ is about

2/5 of $E$, or about 12,000,000 lb. per sq. in. An important case of shearing deformation occurs in shafting subject to torsional moments (twisting action).

The deformations discussed so far are elastic deformations resulting from stresses not exceeding the proportional limit. When a body is stressed beyond its proportional limit, deformations increase more rapidly than the stresses. Hooke's Law no longer holds true. In the case of structural steel, when the stress is somewhat above the proportional limit, a small increase in stress is accompanied by an increase in deformation which is many times the elastic deformation caused by stress equal to the proportional limit. The stress at which this increase in deformation occurs is called the yield point of the steel. A material is said to be ductile in which large nonelastic deformations occur before fracture.

## ALLOWABLE STRESSES

Allowable unit stress, or simply allowable stress, is the unit stress value specified as proper for use in calculating the dimensions of the cross section of a member which is to carry a stated load. There are allowable stresses in tension, compression, and shear. Allowable stresses are either specified by some authority (such as the bridge department of a railroad) or selected by a designer who has adequate knowledge of the conditions of use and the properties of the material. The term working stress is often used for allowable stress.

The aim of structural design in general is to obtain structures that are safe and as light as possible; unnecessary weight is costly. Safety is insured by making each member of such size that the maximum stress in the member is less to a proper degree than the stress at which failure occurs in the material used. Failure does not necessarily mean fracture. A machine or structure fails when it will no longer perform its function satisfactorily. A member made of a ductile material will generally fail if the stress reaches the yield point, because at that stress excessive deformation occurs, rendering the machine or structure useless; on the other hand, if a member is made of a brittle material there is very little distortion and failure occurs when the member breaks.

**Margin of Safety.** The difference between the allowable stress, and the stress at which the material will fail, constitutes a margin of safety which is necessary to provide for: (1) accidental or careless overloading; (2) inexactness of calculation of stress due to simplifying assumptions or unknowable conditions; (3) possible defects in the material that cannot be detected; and (4) possible future deterioration due to corrosion or decay. How large the margin of safety should be is a question, the answer to which requires sound engineering judgment based on experience and a thorough knowledge of all conditions of use and of the behavior and characteristics of the material. Allowable stresses for many materials and uses have been specified by competent authorities and these are widely used by designers.

Examples of widely-used specification of allowable stresses are the *Boiler Construction Code* of the American Society of Mechanical Engineers and the *Specifications for the Design, Fabrication and Erection of Structural Steel Buildings* issued by the American Institute of Steel Construction. Parts of the latter specifications have been incorporated in the building codes of many cities. Specifications are revised at intervals as materials are improved or as other conditions change. An example of the amount of the allowable stress as compared to the yield point and ultimate strengths of the material is taken from the 1946 A.I.S.C. specifications. According to these specifications, the steel for buildings must have an ultimate tensile strength between 60,000 and 72,000 lb. per sq. in. and a yield point not less than 33,000 lb. per sq. in. The specified allowable tensile stress for such steel is 20,000 lb. per sq. in., while many more conservative specifications give the allowable tensile stress as 18,000 lb. per sq. in. A very high allowable stress, 82,000 lb. per sq. in., has been used in designing suspension bridge cables, the specified strength of the steel wires being 220,000 lb. per. sq. in. and the yield point 150,000 lb. per sq. in.

**Factor of Safety.** The factor of safety of a member in a structure is the ratio of the load causing failure to the load causing the allowable stress. For most members, stresses are proportional to the loads and, consequently, the factor of safety is often defined as the ratio of ultimate strength to allowable stress. Thus, if the ultimate strength of structural steel is 72,000 lb. per sq. in. and the allowable stress is 18,000 lb. per sq. in., the factor of safety is four. The term factor of safety, as thus defined, is misleading because a tension member, for instance, would cease to be useful (and would, in that sense, fail) when the stress equals the yield point of the material, about 33,000 lb. per sq. in. for structural steel.

## UNIFORM STRESS DISTRIBUTION

A large part of strength of materials is concerned with the derivation of relationships between given loads, the size and shape of the solid body supporting or resisting the loads, and the resulting unit stresses on a certain cross section of the body. In general, the purpose is to determine the necessary dimensions of the body so that the greatest stress that occurs shall not exceed the allowable stress.

Elementary strength of materials deals with a number of cases of uniformly distributed stress. Among these may be mentioned: tension members, short compression members, thin-walled cylinders resisting internal fluid pressure (tanks and boilers), riveted joints, welded joints, temperature stresses, and statically indeterminate combinations, such as axially loaded tension members of two or more different materials.

If the unit stress is the same on all parts of the cross section, then $S = P/A$. The designer determines the necessary cross-sectional area by dividing the given load by the allowable stress. The beginner, however, must learn to distinguish between cases in which the stress distribution is uniform and other somewhat similar cases in which it is not. It is also necessary (as in the case of riveted joints, for example, in which tensile, compressive and shearing stresses all occur) to learn how to recognize the planes on which each of these stresses occurs and how to find what part of the load is resisted by the stress on each plane.

**Thin-walled Cylinders.** To illustrate, consider a tank or thin-walled cylinder. Such a tank will fail (burst) when

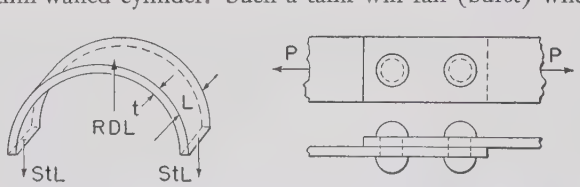



*Fig. 5* (LEFT)—*HALF-HOOP FROM A THIN-WALLED CYLINDER, SHOWING VERTICAL FORCES ACTING; Fig. 6* (RIGHT)—*DOUBLE-RIVETED LAP JOINT*

the tensile stress in the shell becomes equal to the tensile strength of the plate. A formula relating the thickness $t$ of the plate, the internal diameter $D$ of the tank, the stress $S$ in the shell plate, and the internal pressure $R$ (lb. per sq. in.) can be derived by passing two imaginary, transverse planes

$L$ inches apart, cutting the tank. Between these two planes will be a hoop cut from the tank shell. The upper half of this hoop, shown in Fig. 5, is considered as a body in equilibrium. The internal pressure acting on the inner curved surface exerts an upward vertical force equal to $RDL$ and stresses on the two horizontal cut surfaces of the half-hoop exert two downward forces each equal to $tLS$. Equating,

$$RDL = 2tLS, \text{ whence } S = RD/2t.$$

**Riveted Joints.** As an illustration of stresses in a riveted joint, consider two plates joined by two rivets, as shown in Fig. 6. A joint of this type is known as a double-riveted lap joint. Such a joint may fail by shearing off both rivets, by tension in either one of the plates where weakened by the rivet hole, and by excessive bearing stress between the rivets and the plates. Allowable stresses are assumed to be: (1) shearing, 10,000 lb. per sq. in.; (2) tension, 15,000 lb. per sq. in.; and (3) bearing, 20,000 lb. per sq. in. Bearing stress in a riveted joint is defined as the load on one rivet divided by the product of the diameter of the rivet and the thickness of the plate. Let it be required to determine the greatest load $P$ that will not cause stresses greater than the allowable stresses. Each plate is 3 in. wide, ½ in. thick and the diameter of the rivets is 1 in. The area of the cross section of a 1-in. rivet is $\pi \times \frac{1}{4} = 0.785$ sq. in.

(1) $P_s = 2 \times .785 \times 10{,}000 = 15{,}700$ lb.
(2) $P_t = (3 - 1)\frac{1}{2} \times 15{,}000 = 15{,}000$ lb.
(3) $P_b = 2(1 \times \frac{1}{2}) \times 20{,}000 = 20{,}000$ lb.

The smallest of these three values is the allowable load on the joint.

In general, it is true that the stress on a cross section of a tension member or short compression member will be uniformly distributed if the equal and opposite tensile loads are so located that the resultant of each load passes through the centroid of the cross section. There are some cases of nonuniform stress distribution that are dealt with as if the stress were uniformly distributed, such as the case of bearing stress between a rivet and plate in a riveted joint. However, such simplifications must be used with caution.

## NONUNIFORM STRESS DISTRIBUTION

Many structural members and machine parts are so loaded that the unit stresses are not uniform over any cross section. Formulas by means of which stresses may be calculated under these conditions are derived as follows. An imaginary plane containing the cross section on which the stress is wanted cuts the body into two parts, one of which is considered as a body in equilibrium. On this body are one or more given external forces and also the forces resulting from the stresses on the cross section; the stresses must be such that the conditions of equilibrium are satisfied, and must vary in such a way as to be consistent with the deformations of the body. These two conditions lead to the solution of the problem. The second of these two conditions depends upon Hooke's Law. The most common cases of nonuniform stress are: beams, tension or compression members with bending, shafting subject to twisting forces, and columns.

**Beams.** A beam is a long member with transverse loads and supports. Most beams have the same cross section from end to end. The forces exerted by the supports are called reactions. Two types of beams in common use are cantilever beams and beams with two supports, called simple beams. These are represented diagrammatically in Fig. 7. When a beam is loaded, the deformation takes the form of bending. In the simple beam the fibers at the upper surface shorten and those at the lower surface lengthen. It follows that somewhere between the top and bottom of the beam there is a surface that does not change in length. This is called the neutral surface. It is also true that the change in length of any fiber located between the neutral surface and the top (or bottom) of the beam is proportional to the distance of

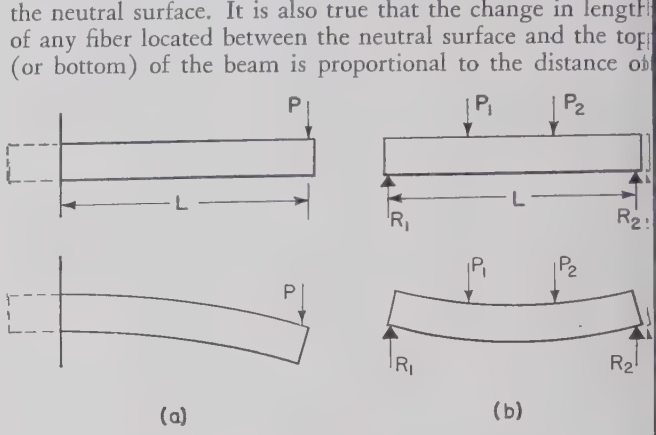



*Fig. 7—TWO COMMON TYPES OF BEAMS*
*(a) Cantilever beam; (b) Simple beam*
*(P, $P_1$, $P_2$) Loads; ($R_1$ and $R_2$) Reactions; and (L) Length*

the fiber from the neutral surface. If Hooke's Law holds, the unit stresses are also proportional to the distance from the neutral axis.

*Flexure Formula.* This law of stress variation, together with the conditions of statics, results in a formula, called the flexure formula, that relates the stresses to the loads and dimensions of the beam. The flexure formula is generally written in the form $S = Mc/I$, in which $S$ is the maximum stress on the cross section, $c$ is the distance from the neutral axis of the cross section to the most stressed fiber, $M$ stands

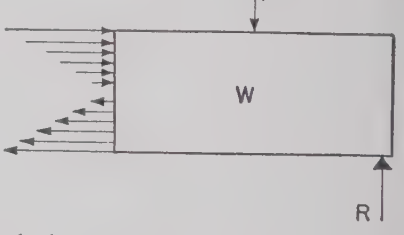



*Fig. 8—VARIATION OF STRESS ON THE CROSS SECTION OF A BEAM*
*(P) Load; (R) Reaction; and (W) Weight*

for bending moment, which is the sum of the moments of all forces on one side of the section, and $I$ stands for the moment of inertia of the cross section and is a function of the shape and size of the cross section. The variation of stress on the cross section of a beam is shown in Fig. 8.

As an example of the calculation of stress in a beam, consider a beam of wood 4 in. wide, 6 in. deep, and resting on supports 120 in. apart. Let it be required to find the maximum bending stress due to a single load of 1,000 lb. at the mid-point of the beam. Because of symmetry, each reaction is 500 lb. The maximum bending moment in a beam with this loading occurs at the mid-point and equals the reaction times half the distance between supports, or $M = 500 \times 60 = 30{,}000$ lb. in.

The moment of inertia of a rectangle is found by the formula $I = \frac{bh^3}{12}$. For this beam $I = \frac{4 \times 6^3}{12} = 72$. The quantity $c$ in this case is half the depth of the beam, or 3 in. Substituting these values:

$$S = \frac{Mc}{I} = \frac{30{,}000 \times 3}{72} = 1{,}250 \text{ lb. per sq. in.,}$$

a rather low stress for any of the common structural timbers.

There are also shearing stresses on cross sections of beams, and the resultant force exerted by the shearing stresses equals the sum of all other vertical forces on one segment of the beam. The sum of all the external loads and reactions on one of the two segments of the beam is known as the shear at the section of the beam and is generally given the symbol $V$. The shearing stresses are not uniform over the cross section, being of zero intensity at the top and bottom edges and nearly always of maximum intensity at the neutral axis.

**Deflections of Beams.** It is often necessary to calculate the amount of the vertical movement or deflection of a point on the neutral surface of a beam as it is bent by loads. This problem is of great importance because an understanding of the deflections and the curvature of beams contributes greatly to the solutions of problems arising in a large class of frames known as indeterminate structures.

As early as 1757, the Swiss mathematician Euler wrote an equation representing the curve of a bent beam. The equation relates the curvature of the beam to the variable bending moment. To find the ordinate of the elastic curve (the deflection) requires the use of the method of double integration. In 1868, Professor Otto Mohr, in Germany, and, in 1873, Professor Charles E. Greene, at the University of Michigan, independently discovered a method making use of the bending moment diagrams of beams. This method is known as the area-moment method and has the great advantage of reducing the mathematics to relatively simple arithmetic. By the methods mentioned, it is possible to calculate the deflection or slope at any point in a beam with any kind of loading. For simple types of loading, formulas for the maximum deflections are readily derived. Two examples of such formulas are: for a cantilever beam with a concentrated load of $P$ at the end, the maximum deflection $y = PL^3/3EI$; for a beam on supports at the ends and with a uniform load $W$ over the entire length, $y = 5WL^3/384EI$.

**Statically Indeterminate Beams.** Many beams used in structures and machines have more than two reactions or have two reactions with one or both ends fixed against rotation. Such beams are called statically indeterminate beams because the equations furnished by statics are not sufficient

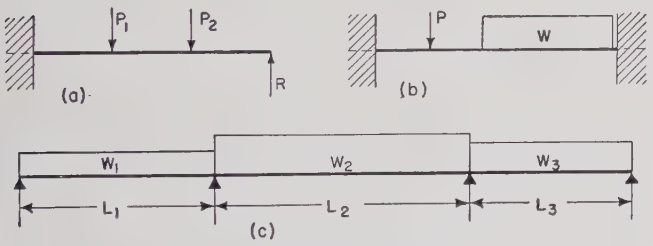



*Fig. 9—INDETERMINATE BEAMS*

*(a) Beam fixed at one end; (b) Beam fixed at both ends; and (c) Continuous beam of three spans*

*($P$, $P_1$, $P_2$) Loads; ($R$) Reaction; ($L_1$, $L_2$, $L_3$) Lengths; ($W$, $W_1$, $W_2$, $W_3$) Weights*

for the determinations of the reactions and end moments. The three types usually studied are: beams fixed at one end and with one support, beams fixed at both ends, and continuous beams (having more than two supports) as shown in Fig. 9. The necessary additional equations for solving such beams are based on conditions of deflection and curvature.

The first solution of continuous beams was published by the French engineer, E. Clapeyron, in 1857. He derived a formula now called the theorem of three moments. This formula, written in many different forms, expresses a relationship that exists between the three bending moments at three successive supports in a continuous beam. As an example, for a continuous beam with a uniform load on each span, the formula is:

$$M_A L_1 + 2M_B(L_1 + L_2) + M_C L_2 = -\frac{W_1 L_1^3}{4} - \frac{W_2 L_2^3}{4}.$$

In this formula, $M_A$, $M_B$ and $M_C$ are the bending moments at the three supports, $L_1$ and $L_2$ are the lengths of the left and right spans, $W_1$ is the load on the left span and $W_2$ is the load on the right-hand span. It is necessary to write this equation for each pair of adjacent spans and then to solve these equations simultaneously. If there are $n$ spans there will be $n - 1$ equations.

In 1930, Professor Hardy Cross published a method for solving a large variety of indeterminate frames, including continuous beams. This method is called moment distribution and avoids the solution of simultaneous equations reducing the calculations to addition and subtraction of numbers.

**Torsional Stress.** If equal and opposite torques or twisting moments are applied to the ends of a piece of shafting, there will be shearing stresses on every cross section. On any circular cross section the shearing stress is zero at the center and of maximum intensity at the outer edge; between these points the unit stress is proportional to the distance from the center. The common torsion formula giving the maximum shearing stress is: $S_s = Tc/J$, in which $T$ is the torque at one end in pound inches, $c$ is the radius of the shaft, and $J$ is the polar moment of the cross section. For a circle, $J = \frac{\pi r^4}{2}$. This torsion formula applies only to circular cross sections. The derivation of formulas for shafts of other cross sections is a problem solved by the mathematical theory of elasticity, aided, in some cases, by ingenious methods of experimental analysis.

As an example of the use of the torsion formula, let it be required to find the allowable torque that may be applied to (or resisted by) a 3-in. diameter steel shaft if the allowable shearing stress $S_s$ is 8,000 lb. per sq. in.

For this problem, the formula is written $T = S_s J/c$. For a 3-in. shaft, $J = \frac{\pi \times 1.5^4}{2} = 7.96$ in.$^4$ and $c$ is the radius of the shaft, 1.5 in. Substituting these values, $T = 8{,}000 \times 7.96/1.5 = 42{,}500$ lb. in. This torque could be exerted by a belt pull of 1,700 lb. at a radius of 25 in., or by any other combination of force and radius such that the force times the radius equals the torque.

**Combined Bending and Direct Stress.** Beams often have tension or compression forces on the ends in addition to the transverse loads and reactions, and there are other cases where tension or compression exists in addition to bending. In such cases, the unit stress at any point in any cross section is the algebraic sum of the direct stress due to the loads perpendicular to the cross section and the bending stress due to the transverse loads. The general formula for combined bending and direct stress is $S = \pm (P/A) \pm (Mc/I)$, in which the plus sign is commonly used to denote tensile stress.

An important case is that of a prism with an eccentric load on the end. As an example, consider the bar $AB$ in Fig. 1 and imagine that the holes at the ends of the bar are not on the geometric axis of the bar but are drilled ¼ in. to the right of this axis. The effect of this eccentricity is

to cause bending stress in addition to the direct tensile stress. The bending moment equals the product of the load and the eccentricity; in this case $M = 10{,}000 \times \frac{1}{4} = 2{,}500$ lb. in. For this bar 1 in. thick and 2 in. wide, $I = 0.67$ in.$^4$ and $c = 1$ in. The formula gives:

$S = +(10{,}000/2) \pm (2{,}500 \times 1/067)$

$= +5{,}000 \pm 3{,}750 = +8{,}750$ lb. per sq. in. at the right edge and $+1{,}250$ lb. per sq. in. at the left edge. Shifting the load only $\frac{1}{4}$ in. has increased the tensile stress by 75 per cent.

**Columns.** Building frames and bridges consist largely of tension members, beams, and columns. Columns are long compression members with loads on the ends. In a building frame, the vertical members that support the floors are columns.

If a compression member is more than 10 or 15 times as long as it is wide, it will bend when loads are applied to the ends, even if the loads are intended to be axial. Due to this bending, the load is eccentric on the cross section at the mid-length of the column. If $D$ is the amount of this eccentricity, the maximum compression stress in the column is $S = (P/A) + (PDc/I)$. Since this stress should not exceed the allowable stress, the load must be less than the load permissible in a short compression member.

A formula for slender columns was derived in 1757 by Euler: The greatest load that a slender column of length $L$ will carry is $P = EA/(L/r)^2$, in which $A$ is the cross-sectional area of the column, and $r$ is the least radius of gyration of the cross section. The quantity $L/r$ is called the slenderness ratio. It will be seen that the load decreases rapidly as the slenderness of the column increases. Euler's formula does not apply to the less slender columns used in building bridges. Such columns are called intermediate columns. No exact analysis for intermediate columns has been made and designers resort to empirical formulas for determining the allowable load as compared with the load permitted on a short compression member. These column formulas give results that are in agreement with the results of tests made on columns with different slenderness ratios. The three most widely used types of column formulas are: the Rankine formula, proposed about 1860 by J. M. Rankine, of the University of Glasgow; the straight-line formula, proposed by T. H. Johnson in 1884; and the parabolic formula, proposed by J. B. Johnson in 1882.

Many formulas of each of these types have been used. As examples, three formulas that have been widely used for the design of structural steel columns in building frames are given below:

Rankine, $$\frac{P}{A} = \frac{1800}{1 + \dfrac{(L/r)^2}{18{,}000}}.$$

Straight line, $$\frac{P}{A} = 16{,}000 - 70L/r.$$

Parabolic, $$\frac{P}{A} = 17{,}000 - .485\,(L/r)^2.$$

In each of these formulas, $P$ is the allowable load, $A$ is the area of the cross section in square inches, $L$ is the unsupported length of the column in inches, and $r$ is the radius of gyration of the cross section, a quantity closely related to $I$, the moment of inertia of the cross section used in the flexure formula.

To illustrate the use of a column formula, let the parabolic formula given above be used to find the allowable end load on a structural steel column of round cross section, 3 in. in diameter, in two cases: (1) the length is 45 in., and (2) the length is 90 in. For a solid, circular cross section, $r$, the radius of gyration is one-fourth of the diameter, or in this example $r = \frac{3}{4}$ in. The area of the cross section is $1.5^2\pi = 7.07$ sq. in. For case (1), $L/r$ is therefore $45/0.75 = 60.$, and, for case (2), $L/r = 120$. Making these substitutions in the formulas:

(1) $P/A = 17{,}000 - .485 \times 60^2 = 15{,}255$ lb. per sq. in.
$P = 15{,}255 \times 7.07 = 108{,}000$ lb.

(2) $P/A = 17{,}000 - .485 \times 120^2 = 10{,}000$ lb. per sq. in.
$P = 10{,}000 \times 7.07 = 70{,}700$ lb.

The allowable load on the more slender column is much less.

Eccentrically-located columns often occur in structures. A theoretically correct analysis of such columns exists and results in the secant formula. Because the use of this formula is laborious, empirical methods giving good results are often used.

## COMBINED STRESSES

There are cases in which the unit stress at a point on a certain plane in a stressed body as calculated by the ordinary formulas is not the greatest unit stress at that point; a greater unit stress exists on some other plane. The relationships between the unit stresses on different planes at a point are important. The term combined stresses is sometimes used to denote the part of the mechanics of materials that treats of these relationships.

**Stress Relationships.** The state of stress at a point in a stressed body may be completely represented by showing the stresses that act on the faces of a cube at that point. The common cases, such as those already discussed, are biaxial stress with no stresses on two opposite faces of the cube. At the same point in the same stressed body, the values of the unit stresses will be different on differently inclined planes. By use of the principles of statics, many important relationships may be derived. Three of these are as follows:

1. If shearing unit stress exists at a point on a given plane, there is an equal shearing unit stress on the plane perpendicular to the given plane at the same point.

2. There is a certain plane on which the normal unit stress is greater than on any other plane.

3. On the plane perpendicular to this plane, the normal unit stress is less than it is on any other plane. The maximum and minimum normal stresses referred to in (2) and (3) are called the principal stresses and the planes on which they act are called the principal planes.

In ordinary design procedure it is rarely necessary to calculate the principal stresses by the methods just given because the simple formulas in common use give maximum stresses in most cases. Combined stresses must be used, however, in many problems such as designing a shaft subject to both torsion and bending moment.

## ADVANCED PROBLEMS

Numerous problems other than those mentioned are within the scope of strength of materials. Many of these are regarded as advanced problems. In the cases so far mentioned, the stress is either treated as uniformly distributed, or the stress at a point in a cross section is assumed to be proportional to the distance of the point from an axis where the stress is zero. There are many cases of stress varying in a more complex way. Such cases are commonly regarded as advanced problems outside the field of elementary strength of materials.

Common examples of nonlinear stress variation include: curved beams, thick cylinders subject to internal or external pressure, shafting with noncircular cross sections, and loaded bodies in which there are abrupt changes in cross section, such as grooves, notches, holes or fillets. The stressed bodies considered so far were assumed to be loaded with static loads, gradually applied or gradually removed. Variable or fluctuating loads, if repeated millions of times, may cause failure even though the stresses are somewhat less than the strength of the material. Such failures are called fatigue failures, and the problem of avoiding them is of great importance because of the wide use of high speed machinery. *See also* Elasticity; Engineering Materials; Statics; Structure Analysis. P. G. L.

**STREPSIPTERA** [strɛpsɪ′ptərə], both the scientific and common name of a peculiar group of small insects which form an order of the same name. They are mostly parasitic on bugs, bees, wasps, and Orthoptera. They are closely related to the beetles. The females are thin skinned, cylindrical or flattened, and never leave the body of their host. The males have multifolded wings that fit under the small wing covers: they locate and fertilize the females within the body of the host. The very numerous primary larvae are very active and escape from the body of the mother to that of the host, and thence to flowers or to the ground. They then attach themselves to a new host and bore into it, or, in the case of bees and wasps, are carried to the bee's nest where they attack the bee larvae. Once inside the host, the larvae molt and then look like tiny white grubs. The adult males live only two or three days. C. H. Cu.

**STREPTOMYCIN.** *See* Antibiotics.

**STREPTOSOLEN** [strɛptoso′lən], an evergreen shrub of the potato family represented by one species, *S. jamesonii*, a native of Colombia and Ecuador. It has showy orange flowers, growing 4 to 6 ft. high, and is hardy as far north as San Francisco, California. L. de F.

**STRESEMANN, GUSTAV** [shtre′zəmɑn] (1878-1929), German statesman, was born May 10, 1878, in Berlin. He was educated at the Universities of Berlin and Leipzig, specializing in philosophy, political science, and economics. Stresemann early showed signs of organizing ability, and at the age of twenty-three became secretary of the Union of Saxon Chocolate Manufacturers. Two years later he helped found the League of Saxon Manufacturers, whose purpose it was to organize and improve the local industries.

As a member of the National Liberal Party, Stresemann was elected to the Reichstag in 1907. Ten years later, on the death of Ernst Bassermann, he became head of the party, which included such leading industrialists as Hugo Stinnes. During World War I, Stresemann repeatedly attacked Chancellor Theobald von Bethmann-Hollweg for his weak policies and clamored for a more vigorous prosecution of the war. In 1918 he reorganized his following as the German People's Party which, although monarchistic in sympathies, was ready to support the republic in the interests of peace, national unity, and good business. At the Weimar Assembly of 1919 he voted against the acceptance of the Peace Treaty. In August 1923 Stresemann succeeded Wilhelm Cuno as chancellor. The assignment was most difficult, since Germany at the time was seething with internal disorders, particularly in Bavaria, Saxony, and Thuringia; and the Franco-Belgian occupation of the Ruhr created further problems. Within less than fifteen weeks the government fell, to be succeeded by a new one under Dr. Wilhelm Marx. Stresemann, however, became foreign minister in the new cabinet. He retained this portfolio under all successive ministries until his death in Berlin, Oct. 3, 1929.

Stresemann's accomplishments as foreign minister established his pre-eminence among Germany's post-war statesmen. He discontinued the policy of passive resistance against the French and Belgians in the Ruhr; he was to a large extent responsible for the adoption of the Experts' or Dawes Plan for reparations, with its resultant loan to Germany and evacuation of the Ruhr; he took a leading part in the negotiation of the Locarno Treaties, 1925; he signed a treaty with Russia June 29, 1926; he labored for the admission of Germany into the League of Nations, 1926; he welcomed the opportunity to bring about German adherence to the Kellogg Pact; he fought for the acceptance of the Young Plan for reparations in 1929; and he secured a promise from the Allies that the Rhineland would early be evacuated. Stresemann was also in favor of Aristide Briand's plan for Pan-Europa. It was due largely to Stresemann's gifted oratory and his personal charm that friendly relations were so soon re-established between Germany and the former Allies. In 1926 he, together with Briand and Sir Joseph Austen Chamberlain, won recognition for their services in the cause of world peace by being awarded the Nobel Peace Prize. He died at Berlin Oct. 3, 1929. R. H. L.

**STRETHER, LEWIS LAMBERT** [strɛ′thər], the "observer" and principal character in the novel *The Ambassadors* (1903), by Henry James. Strether's consciousness of his world is the center of interest of the work. W. Y. T.

**STRETTO** [strɛ′tto], a term in music to designate the concluding section of a fugue, in which the subject is imitated in the different parts with much overlapping and dovetailing and a consequent increase in excitement and intensity. The term is also used to refer to the conclusion of non-fugal pieces, in which a similar heightening of intensity is achieved by accelerating the tempo and breaking up the rhythmic patterns into quicker figures in a process known as "diminution." W. Li.

**STREUVELS, STIJN** [strö′vəls] (1871- ), Belgian novelist, whose real name was Frank Lateur, was born at Heule on Oct. 4, 1871. He was a cousin of the poet Guido Gezelle. While working at a village bakery, Streuvels avidly read Scandinavian and Russian writers in translation and, influenced by them, began his literary career with a series of short stories about the peasant life of Flanders.

The pessimistic undertones of Streuvels' tales were quite new in a literature which until then had depicted rural life in roseate colors. Their literary quality also was surprising; Streuvels from the outset showed a true sense of epic grandeur. In his tales, men and women are represented as the victims of elementary forces; the climate and the scenery have an active role in the proceedings. Nature exists for Streuvels as actively and vividly as do his personages. There is a Biblical, a Homeric simplicity in his stories, which is sometimes reminiscent of the works of Maxim Gorky and of Knut Hamsun, but, indeed, as a writer Streuvels is as Flemish and as natural as the Flemish earth. His attempts at deeper psychological insight may have failed in some of his works, but he proved himself a remarkable analyst of the souls of children. The highlights of his work are *De Vlaschaard* (1907) ("The Flax Field"), which depicts a familiar tragedy on a

farm, and *Leven en Dood in den Ast,* a shorter story, which may well be his masterpiece. *Langs de Wegen* (1902) was translated into English as *The Path of Life* (1915). His *Collected Works* were published in 1952-1954. Though his work is largely concerned with the depressed classes of rural Flanders, its social implications are implicit rather than explicit, epic rather than sociological. J. A. G.

**STRIKES.** *See* LABOR PRACTICES AND EMPLOYMENT (*Nature of Labor Disputes*).

**STRINDBERG, AUGUST** [strĭ'nbæry] (1849-1912), Swedish author and dramatist, was born on Jan. 22, 1849, in Stockholm, where his father was a merchant. His childhood

AUGUST STRINDBERG

BROWN BROTHERS

was unhappy, and when he finished his schooling he had to provide for himself. Restless and without means, and cherishing a desire to be an artist and an actor, he planned for a career in various fields. He studied for some time for a philosophical degree, turned to the study of medicine, and before the age of twenty he had some experience as a teacher and a writer. His early religious interests were affected by his admiration of the American Unitarian minister, Theodore Parker, and he became a free thinker; the influence of H. T. Buckle, the English historian, helped to make him a materialist.

The first important product of Strindberg's literary career was a historical drama, *Mäster Olof* (1878; Eng. tr. *Master Olof,* 1915). The background of the play is well painted, but the author's plan was merely to show that all theories have only a limited validity—that what is true today is a lie tomorrow. *Mäster Olof* was not at first a great success, but when Strindberg published his novel *Röda rummet* (1879; *The Red Room,* 1913), he met with real recognition. This was the first great social novel in Swedish literature, and the author was regarded as the leader of a new naturalistic school. He held a position at the Royal Library and married the actress Siri von Essen; but the criticism that his novel received in the conservative press strengthened his feeling that he was essentially a rebel against the established order. In 1882 he published *Det nya riket* ("The New State"), a satire on the Swedish society of his time, and he expressed his ideas also in several plays and a collection of historical novels, among them *Svenska öden och äventyr* (1882; "Swedish Destinies and Adventures").

In 1883, Strindberg left Sweden, and for a time he settled down with his family, first in France and then in Switzerland. In Switzerland he met some Russian political exiles and became more interested than before in social problems. His own marriage experiences provided the background for a collection of short stories in which he opposed the emancipation of women (*Gittas,* 1884; *Married,* 1913). Because of a disrespectful reference to the Lord's Supper in one of these stories he was prosecuted for blasphemy and, although he was acquitted, the episode seems to have been too much for his vivid temperament. He developed a persecution mania, and in the following years he verged on insanity.

After the publication in 1884 of *Utopier i verkligheten* ("Utopias Realized"), which contained fictional discussions of social and economic problems, Strindberg devoted himself for the next five years chiefly to the writing of novels and short stories. In some of these, especially in *Hemsöborna* (1887; "The People of Hemso") and Skärkarlsliv (1888; "Skerry Life"), Swedish nature and folk life are superbly portrayed. He also wrote several naturalistic dramas, among them *Fadern* (1887; *The Father,* 1899), and *Fröken Julie* (1888; *Miss Julia,* 1912; *Miss Julie,* 1914). Strindberg's domestic difficulties, which are echoed in these plays, resulted in his divorce in 1891. He married again, but his second marriage, to Frida Uhl, was of short duration. He occupied himself mainly with a study of the sciences, including alchemy, and in the closing years of the century he passed through a religious crisis, which he depicted in *Inferno* (1897); *Legender* (1898; "Legends"), and *Till Damaskus* (1898-1904; "To Damascus").

Strindberg's last and most productive period began with the composition of *Till Damaskus.* He married for a third time, but this union, with Harriet Bosse, was brief also. Among his important works of this period are several novels and the dramas *Gustaf Vasa* (1899); *Påsk* (1901; "Easter"); *Dödsdansen* (1901; "The Dance of Death"); and *Kronbruden* (1902; "The Crowned Bride"). He supported a theatre, the "Intima teatern," which specialized in his plays, and he contributed numerous comments on current political problems to the press. On May 14, 1912, he died of cancer in Stockholm.

Strindberg is one of the most colorful personalities in Swedish literature. All the ideas of his generation—social, religious, and political—became his personal problems, which he felt obliged to discuss simply because he had never been able to solve them. As a novelist, as well as playwright, he introduced a new period in Swedish literature, and as a master of style he is unsurpassed. The importance of his work has been variously assessed, but present-day historians of literature seem to agree that it constitutes, as a whole, the finest contribution to Swedish national literature in the nineteenth and early twentieth centuries. A. Wi.

**STRITCH, SAMUEL** (1887- ), Cardinal Priest, Archbishop of Chicago, was born Aug. 17, 1887, at Nashville, Tenn., the son of Garrett and Katherine (Malley) Stritch. Educated at St. Gregory's Preparatory Seminary, Cincinnati, Ohio, and at the North American College in Rome, he was ordained a priest May 21, 1909, in Rome by Pietro Cardinal Respighi, vicar general of Pius X. Engaged in pastor work in the diocese of Nashville, 1910-1917, and Chancellor of the diocese, 1917-1921, he was appointed Bishop of Toledo, Aug. 10, 1921, and consecrated there on Nov. 30, 1921. Promoted to the metropolitan see of Milwaukee on Aug. 26, 1930, and transferred to the metropolitan see of Chicago on Jan. 5, 1940, he was raised to the cardinalate on Feb. 21, 1946. W. C.

**STROBILANTHES** [strɒbɪla′nthiz], a group of herbs and small shrubs, cultivated under glass in temperate regions for their bloom and foliage. These plants are sometimes known under the name "conehead." They are native to the India-Burma region where they grow to about 3 ft. high.

J. C. Wis.

**STROMBOLI** [stro′mboli], one of the volcanic islands of the Lipari or Aeolian group, lying off the northeast coast of Sicily. About 5 sq. mi. in area, Stromboli owes its Greek name of Strongyle to its round shape, and it is easily recognizable by its conical form, a clear indication of its volcanic nature. The highest peaks, Serra Vancura and La Cima, which reach an altitude of over 3,000 ft., are the remnants of the old crater, now inactive and crumbling. The area of the continually active craters is located directly northwest of those peaks, at an altitude of some 2,300 ft. The main product of the island is the wine called mavasia. Other occupations are fishing and sailing. Communications with Sicily and with the Italian mainland are assured by a steamship service connecting Lipari and Stromboli with Messina and Naples. The population is mostly grouped in the villages of Stromboli (formerly San Vincenzo), San Bartolomeo, and Ginostra. Pop. 915. *See also* LIPARI.

L. J. W.

**STRONTIANITE** [strɒ′nshənait], naturally occurring strontium carbonate, $SrCO_3$. It is usually white or gray and fibrous. The specific gravity is 3.7, which is high for a nonmetallic mineral. Strontianite gives the red flame of strontium before the blowpipe and is soluble in powdered form with effervescence in dilute acid. It occurs in shallow veins of either ground-water or hydrothermal origin. Strontianite may also be formed by the alteration of the sulphate, celestite. It has been mined in Westfalia, Germany, as a source of strontium.

K. K. L.

**STRONTIUM** [strɒ′nshiəm], symbol Sr., atomic number 38, at. wt. 87.63, density 2.54, m.p. 800° C., b.p. 1,150° C. Strontium, named after Strontian, a town in Scotland, is the central member of the triad which includes calcium and barium. Strontium is a typical member of the alkali earth family in Group II-A of the periodic table. Its atom contains four completed shells of electrons (2, 8, 18, 8) and an outermost shell containing 2 valence electrons. Strontium is always bivalent and strikingly intermediate between calcium and barium in its physical and chemical properties.

Strontium metal, first prepared by Humphry Davy in 1807, is almost a curiosity. It is white, sometimes showing a faint yellow tint, malleable and ductile; it tarnishes quickly in air and takes fire from friction. It decomposes water and alcohol.

**Occurrence.** Strontium minerals are mainly the carbonate (strontianite, $SrCO_3$) and the sulphate (celestite, $SrSO_4$). Deposits of strontium minerals are reported from California, Washington, Arizona, and Texas. Imports are chiefly from Mexico, Spain, and England.

**Principal Compounds and Uses.** Strontium compounds are similar to those of calcium and are prepared by the same methods. The bromide $SrBr_2 \cdot 6H_2O$ forms colorless, deliquescent crystals, readily soluble in water, giving a bitter, salty neutral solution used in treating epilepsy, hysteria, insomnia, and convulsions. Strontium chloride, $SrCl_2$, is used in welding fluxes and in salt baths for treating steel. Strontium carbonate, $SrCO_3$, is a white, insoluble powder used in pyrotechnics and the refining of sugar. Strontium chlorate, $Sr(ClO_3)_2$, is a white crystalline salt, readily soluble, used in pyrotechnics. Strontium hydroxide, $Sr(OH)_2$, is moderately soluble in water, forming a very alkaline solution ($p$H about 13.5). It is used sometimes to remove the last amounts of sugar from molasses (Steggen's process); and it is also used in the manufacture of phosphorescent compounds, fluorescent lighting devices, and depilatory preparations. Strontium lactate, $Sr(C_3H_5O_3)_2 \cdot 3H_2O$, a white crystalline powder, difficultly soluble, is used as a mild antiseptic, antipyretic, and analgesic. Strontium nitrate, $Sr(NO_3)_2$, is a white powder, readily soluble, giving a neutral solution. It is used in pyrotechnics, signal fires, and similar applications. Other uses of strontium are in the removal of iron and magnanese in the purification of caustic soda; and in the production of enamels, glazes, and glass.

B. S. H.

**STROPHANTHUS** [strofa′nthəs], a genus of the dogbane family, made up of about 30 species of trees and shrubs native to Africa and Asia. The climbing South African species, *S. hispidus,* yields seeds from which the glucoside strophanthin is made. It is used like digitalis in treating heart disturbances, particularly those accompanying certain forms of goiter. Some African tribes use these seeds to make arrow poison.

J. A. Bo.

**STROUDSBURG** [strau′dzbɜrg], an industrial borough and summer resort in eastern Pennsylvania, the county seat of Monroe Co. It is situated in the foothills of the Pocono Mts., about 3 mi. west of the Delaware Water Gap and the New Jersey border, and 40 mi. southeast of Scranton. The surrounding area is one of diversified farming. Coal and clay are natural resources. In 1776, on the site of the borough, Colonel Jacob Stroud built a stockade which two years later became a refuge for survivors of the Wyoming Massacre. Stroudsburg was founded in 1806. It has the mayor-council form of government. Transportation is provided by the Delaware, Lackawanna and Western and the Pennsylvania railroads. Manufactures include galvanized products, telephone-line equipment, septic tanks, boilers, mowers, rayon, silk, hosiery, hoists, glass, beverages, and cheese. Severe flood damage in August 1955 seriously affected these industries. Pop. 1950, 6,361.

**STROZZI, BERNARDO** [strɔ′ttsi] (1581-1644), Italian painter, was born in Genoa in 1581. He took the vows of the Capuchin Order but was later released and in 1630 went to Venice, where he remained until his death on Aug. 2, 1644. Through contact with the art of Caravaggio and of Rubens, who were in Genoa in 1605 and 1607 respectively, and of the earlier Venetians, Strozzi broke with the Mannerism of his early style and developed the rich colorism which is his distinctive quality. In his figure types, which are vigorously modeled and heavily draped, he belongs to the Baroque period; in technical bravura and chromatic mastery, exemplified by his *Rape of Europe* (Posen Museum) and *St. Sebastian* (San Benedetto, Venice), he contributed, with Domenico Fetti and Jan Lys, to the revitalization of the Venetian tradition after its Manneristic decline.

M. C.

**STRUCTURAL ENGINEERING.** *See* BRIDGES; BUILDING CONSTRUCTION; STRUCTURE ANALYSIS.

**STRUCTURALISM,** a system of psychology which sought to investigate and to describe the composition and integration of experience. It was established, principally by Edward Bradford Titchener, during the last decade of the nineteenth century in opposition to functionalism. Titchener's formulation rested upon his ideas of what science is and

what it attempts to do. He held that the objects of science were facts, that its aim was to understand, and that the attitude of the man of science was disinterested and impersonal. Value and use were consequently taboo in structuralism, as were also the interested and personal attitudes of common sense and technology. Titchener held that the subject matter, problem, and method of all the sciences, including psychology, was the same: the subject matter being the world of experience; the problem, description and explanation; and the method, observation. He differentiated the sciences by point of view. Structuralism undertook to describe and to explain the world of experience from the point of view of the experiencing individual.

Among the various methods employed was introspection—a looking-within at the existing facts of experience. Every available method was used to achieve the ends of description and explanation. Introspection was, however, the chief method of structuralism, and it was used so consistently that the school is sometimes referred to, though incorrectly, as "introspectionism."

The first task of psychology from the structural point of view was to analyze experience into its elementary processes. Of the many elements proposed by various investigators—affection, conation, form quality, image, relation, thought, and sensation—Titchener settled on three: sensation, image, and affection. The others listed could, he believed, be reduced under ultimate analysis to one or another of those selected. He thought, moreover, that if there were any change in the future it would "come by way of addition and not of subtraction." The elements were defined by the enumeration of their attributes—moments, aspects, dimensions, ways in which they could be separately observed. There was, however, no more agreement in psychology about the attributes of the elements than about the elements themselves. Relying upon the two criteria of inseparability (the annihilation of any member of an attributive group annihilates the entire group) and independent variability (variation with limits of one attribute without disturbing the others), Titchener found that every sensation possessed the four attributes of quality, intensity, clearness, and duration, and that vision and pressure possessed the fifth attribute of extent. He also found that images possessed the same attributes as sensation and that affection possessed quality, intensity, and duration. The sensory processes were divided upon the basis of their qualitative resemblance into modalities—discrete qualitative continua.

At a higher level of integration he considered: (1) recognition, direct apprehension, and the perception of the strange or new—complexes based on perception but differentiated by integral feelings and enriched by integrated ideas; (2) memory, recall, and imagination—complexes based on idea but again differentiated by feeling and contributed to slightly by perception; and (3) emotion—based on feeling but contributed to in varying measure by perception and idea. From this level he passed to action, thought, and judgment, and finally to the integration of the self—the experiencing individual with whom he started.

Structuralism was systematic and experimental from beginning to end, and its concern was the description and explanation of observable facts. About fifteen years after it had decided upon its elements—when it was shown by experiments that sensation and image differed not in kind but only in degree and that there was only a psychophysical difference between them (sensation being aroused by stimuli from without the central nervous system and images from within it)—Titchener dropped image and reduced the elementary processes to sensation and affection. Still later, in 1924, when the affective qualities of pleasantness and unpleasantness seemed to be correlated with bright and dull pressures respectively, he reduced the elements to sensation, and his system passed into the form of "sensationism."

Structuralism was concerned only with observables. Since functions and operations could not be observed, but only inferred, they were excluded from the structuralist's consideration. The distinction between structure and function was, however, "no more than a working schema by which one's present knowledge may be temporarily arranged—a schema to be ruthlessly discarded as soon as a better is proposed."

Structuralism stemmed from Wundt's content psychology, which stood in opposition to Brentano's act psychology (the antecedent of American functionalism). The first, however, to draw the distinction in America between the two points of view was James. In a paper in 1884, he distinguished sharply between the structural and functional aspects of psychology. Titchener was trained in Wundt's laboratory, in which emphasis was placed upon analytical observation and the examination of the elementary processes and modes of connection. Structuralism and functionalism supplemented each other, though each had the underlying conviction that it was itself the main reliance of psychology. When, however, functionalism disappeared from the American scene around 1912, under the impact of behaviorism, structuralism soon followed. By 1918 Titchener had turned to phenomenology and existential psychology, and in 1921 he wrote: "Both functional and structural, as qualifications of psychology, are now obsolete terms." *See also* BEHAVIORISM; EXPERIMENTAL PSYCHOLOGY; FUNCTIONALISM. K. M. D.

**STRUCTURAL LINGUISTICS,** a trend in modern linguistics which had its origin in certain observations by Baudouin de Courtenay and Matteo Bartoli but is based essentially on Ferdinand de Saussure's *Cours de linguistique générale* (1916). It was developed in recent years by the so-called Prague School, a group of linguists led by Roman Jakobson and Prince Nikolai Trubetskoy, and by several American scholars (notably E. A. Speiser, B. Bloch, M. Swadesh).

Structural linguistics is one aspect of synchronic linguistics—that is, the study of language at a given moment in time—as opposed to diachronic linguistics, the study of language from the historical or genetic point of view. Areal linguistics also investigates language synchronically, with reference to its position in space, but structural linguistics considers it as a structure or system, a harmonious and coherent whole, in which every piece is inextricably joined to all the others and cannot be understood separately. Structural linguistics is therefore essentially functional, for its studies how every element of language functions within the whole structure. For example, the meaning of the word *obtain* in English cannot be fully grasped unless due consideration is given to words that are semantically close to it, such as *receive, get,* and others; in French or Italian, languages that have no real equivalent of the verb *get,* the semantic areas of *obtain* (*obtenir, ottenere*) and *receive* (*recevoir, ricévere*) are for that reason wider than in English. Every word, like every linguistic form or sound, is limited, and so defined, by others. Thus the English preterit *I gave* is limited by the other past tenses *I was giving* and *I have given; I gave* differs in meaning from the Italian *diedi,* because the semantic area of *davo* and *stavo dando* is not the same as that of *I was giving,* nor does *ho dato* correspond to *I have given.*

The same limitations apply to the sounds of a language,

for these, when considered from the structural or functional point of view, are differentiated by their opposition to other sounds. Thus, in English, the sound (or, in structural terminology, the phoneme) *n* is opposed to the nasals *m* and *ŋ* because, unlike them, it is a dental; it is likewise opposed to the dentals *t* and *d* because, unlike them, it is a nasal; and these two oppositions delimit or define the phoneme *n*. The dental phoneme *d*, on the other hand, is defined with respect to the dental phoneme *t* by its voiced articulation. In Italian, open *ę* and closed *ẹ* are two different phonemes, for several words are semantically distinguished merely by this opposition (e.g., *pęsca,* "peach," and *pẹsca,* "fishing"; *accętta,* "he accepts," and *accẹtta,* "axe"). In Spanish the same difference between *ę* and *ẹ* also exists, but since it is merely positional and does not characterize a word, two phonemes are not involved. Phonemes are therefore semantic entities, related to man's spiritual life, whereas sounds are mere mechanical products, without any real linguistic importance. Sounds and only sounds are perceptible by phonetic devices; to grasp phonemes, knowledge of the language in question is required.

It follows that while the number of sounds that can be uttered by any speaker is virtually unending, the number of phonemes is usually limited to a range between 20 and 50. As a general rule, alphabets take account of phonemes only, and therefore it is possible for most alphabets to satisfy the needs of speakers with 20 to 30 or 35 signs.

The new structural conception of language requires the use of methods that are quite distinct from those demanded by the old historical conception. For example, in considering the function of the preterit *I saw,* or the function of the *-s* plural in Modern English, the student of structural linguistics is obliged to ignore all questions concerning the origin and development of these forms or sounds in the past. Such problems would only confuse his purpose, for in this investigation he is concerned exclusively with Modern English, and, if possible, with the Modern English of a particular decade or year or month. He must compare the Modern English preterit with all the other modern tenses, and he must study the whole Modern English verbal system, but the Old English and Middle English verbs are not his concern.

Nevertheless, the new structural conception has not failed to exercise a renovating and fecundating influence on historical linguistics. The Neogrammarians of the late nineteenth century used to compare one sound, form, or word of Latin with its Modern Italian counterpart, isolating it from all the rest of the language. This practice has been abandoned, under the impact of structural linguistics, in favor of a comparison between the whole system of Latin and the whole system of Italian. Although there is therefore a sharp separation in method between structural and historical linguistics, there is by no means contradiction. Indeed, Roman Jakobson, the founder of the new method, regards himself as primarily an historian.

An important phenomenon in the field of structural linguistics is the existence of stable and unstable language systems. As in the world of animals or of plants, certain language systems are successful and vital because they are fully harmonious; others, which are less harmonious, are unstable; and no completely absurd system is known to exist. It is obvious that a system that has *k, t, p* and *g, d* should also have a *b* to fill the sixth place, and although such defective systems exist, they are rare and unstable and usually develop a *b* in the course of time. A system that has an *ö* (e.g. German, Norse, and French) usually has an *ü* as well; these two phonemes seem to be vitally linked, and a language that has *ü* but no *ö,* like Ancient Greek, eventually looses its *ü*.

In the application of the structural method to language, at least one reservation needs to be made. Although structuralists frequently speak of "the system" of English, French, or any given language, it should be remembered that every language has at least three systems: the predominant one, the one that is outgrown, and the new one that is developing. Thus, in English, *I love : I loved* exists side by side with *I give : I gave; cat : cats* with *mouse : mice;* and in French, *je chante, tu chantes, il chante,* etc., with *je suis, tu es, il est,* etc. Moreover, if a system were perfectly harmonious and coherent, it would never change, whereas it is known that all languages pass sooner or later from one system to another. The difficulties of the new functional theory are great, but it has made noteworthy progress in the time of a single generation of scholars. G. B.

**STRUCTURE ANALYSIS,** the initial phase in designing structural members, in which all the forces that will act on them are determined.

**Relation of Analysis to Design.** The primary problem of the structural engineer is to proportion and assemble various materials as economically as possible into structural units that will support safely the forces which will act upon these units. A building or a bridge consists of an assembly of basic structural units, such as beams, compression members, and tension members. In designing a bridge, the engineer must first determine the loads or forces and calculate various effects due to them before he can design the units which make up the bridge. For example, if a steel beam is to be designed, the loads and reactions, the shears, and the bending moments must first be determined. If a truss (an assembly of tension and compression members) is wanted, the loads, reactions, and the total forces or stresses in each truss member must first be determined. During this part of the procedure, termed analysis, the beam and the truss exist only as line diagrams.

The next step is to determine proportions and select actual sizes. In doing this, however, the designer does not analyze the stress intensities (in other words, the unit stresses) within the beam or the truss. Maximum unit stresses for a particular material, such as medium carbon steel, are already prescribed in design specifications, as those of the American Institute of Steel Construction for buildings, or those of the American Railway Engineering Association for bridges. With these specifications as a guide, the designer calculates the proportions of a beam or girder, such that the limiting unit stresses will not be exceeded when the maximum shears and the maximum bending moments act at various critical sections.

The reader should keep clearly in mind this distinction between the analysis of line diagrams for the determination of maximum shears or bending moments or total stresses and the actual design, which involves a selection of material and its proportions in accordance with governing specifications.

**Basic Factors in Analysis.** *Equilibrium of Forces.* The most important factor in the analysis of structures is the law of equilibrium of forces. The structural engineer is concerned primarily with structures which are at rest under the action of various forces. Although the forces may be moving loads, such as highway trucks, the structure itself does not move, except that it may vibrate. For a structural unit which exists in one plane and which is loaded in that plane, the forces must consequently be in equilibrium, as expressed

by the following equations of statics for a nonconcurrent force system in one plane; a nonconcurrent force system being defined as one in which the forces do not intersect at a single point:

$$\Sigma F_x = 0 \quad (1)$$
$$\Sigma F_y = 0 \quad (2)$$
$$\Sigma M_{xy} = 0 \quad (3)$$

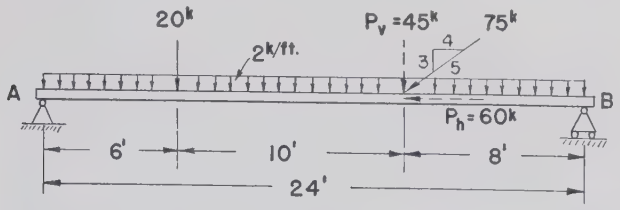
These equations state that the sum of the horizontal force components (1) must balance, that the sum of the vertical force components (2) must balance, and that the sum of the moments of the forces about any point in the plane (3) must balance. When structures are statically determinate, the preceding three equations are sufficient to analyze the effects of force systems.

When there are more than three unknown forces or factors, the structure is said to be statically indeterminate. A structure may be statically indeterminate with respect to the external loads and reactions acting upon it, such as a beam continuous over two spans; or it may be internally statically indeterminate, such as a truss with extra diagonal bars. The analysis of statically determinate units will first be discussed; subsequently the method for treating statically indeterminate structures will be presented.

*Dead Loads and Live Loads.* The loads and forces acting upon structural units may be divided into two general groups, dead loads and live loads. Dead loads are those which are fixed permanently in position. They are often called gravity loads because they act vertically. The weight of a floor slab, beam, or truss or the weights of mechanical equipment fixed permanently in place are considered as dead loads. Live loads, on the other hand, may move on and off a structural unit, or are readily movable. People in a building, trucks on a bridge, furniture in rooms, and snow on the roof are all live loads. The weights of such loads may be readily determined, but there are other types of live loads, such as wind, impact, traction, temperature, and earthquake forces, that cannot be definitely calculated.

## SIMPLE BEAMS AND TRUSSES

**Reactions, Shears, and Moments for Simple Beams.** The effects of loads fixed in position will now be considered. The first step in the analysis of a simple beam is the determination of the reactions due to the loads. In Fig. 1, the reactions (forces) acting at $A$ and $B$, the supports of the beam, are to be found. The loads acting on the beam are given in kips. One kip equals 1,000 lb. The reactions are actually a part of the external load system but they are not known initially. It is necessary to determine the magnitude, direction, and line of action of each reaction in order to define it completely. In the beam there is a frictionless pin at support $A$ and a pin and a rocker at support $B$. The reaction $R_a$, at $A$, must pass through the pin, and consequently the only unknowns here are the direction and the magnitude. Another way of defining these two unknowns is to state that the horizontal and vertical components of $R_a$ are unknown. The reaction $R_b$, at $B$, must pass through the pin at $B$, but it also must be perpendicular to the plane on which the rollers rest. The rollers are assumed to be frictionless, and consequently any force transmitted through them must be perpendicular to the surface on which they roll. Therefore, both the line of action and the direction are known for $R_b$ and the only unknown is the magnitude. The total number of unknowns is three and there are three equations of statics available.




$48 \times \frac{12}{24} = 24^k \uparrow$

$20 \times \frac{18}{24} = 15^k \uparrow$

$45 \times \frac{8}{24} = 15^k \uparrow$

$R_{a_v} = 54^k \uparrow$

$P_h = 60^k \leftarrow$

$R_{a_h} = 60^k \rightarrow$

$48^k \downarrow$

$20^k \downarrow$

$P_v = 45^k \downarrow$

$P = 113^k \downarrow$

$R_{a_v} = 54^k \uparrow$

$R_b = 59^k \uparrow$

*Fig. 1—DETERMINATION OF REACTIONS IN A SIMPLE BEAM*

It will be found convenient to use Equation (3) initially. By taking moments about the pin at $B$, the resulting equation will have only one unknown force, the vertical component of $R_a$, or $R_{a_v}$. Note the calculations in Fig. 1, in which the superscript symbol $^k$ stands for kips. Each load is treated separately, and the moment due to a particular load is immediately divided by the lever arm from $A$ to $B$ in order to get that part of the left reaction due to the particular load under consideration. This method of calculation saves time and reduces the possibility of error by making it easy to calculate mentally the approximate value of the answer. Moreover, it lends itself to a concise arrangement of calculations. After the value of $R_{a_v}$ for each load is thus determined, the results are added algebraically to give the total vertical reaction at $A$.

The reaction at $B$ is determined by using Equation (2) for the equilibrium of vertical forces. The loads acting downward are added, the value of $R_{a_v}$ is subtracted, and the remainder is $R_b$. Finally, from Equation (1), the horizontal component of the reaction at $A$ is obtained.

After the reactions for a given beam have been determined, it is necessary to determine how various internal sections of the beam are affected by the external loads. This requires a determination of shears and bending moments. Note the beam in Fig. 2*a*. The beam as a whole is in equilibrium under the loads and reactions. If the beam is assumed to be cut into two parts, as in Fig 2*b*, without disturbing any of the external or internal forces, each part is also in equilibrium. The internal forces at the cut section must not be overlooked, however, in applying the laws of statics. Actually, the beam is not cut, but in order to aid the analysis of internal effects imaginary sections are passed across the beam, cutting it into free-body diagrams.

There is a shearing effect $V$ on the cut section. Shear is defined as the algebraic summation of the forces parallel to, and on one side of, a section. Note the forces on the left side of section 1. There is a reaction of 45 kips acting upward and a downward load of 40 kips. Hence, $V_1$ equals 5 kips upward on the left side of the section and is defined as positive shear. Note Fig. 2*c*, showing the two free bodies created by passing section 2. The algebraic summation of the loads to the left results in a value of shear equal to 15 kips, downward on the left side of the section; this downward direction defines it as negative shear.

It is not convenient to sketch a large number of diagrams such as those illustrated. It is better to plot a shear diagram

like that in Fig. 2*d* which shows the variation in shear from section to section. Distances along the beam are used as abscissas and the corresponding values of shear as ordinates in this diagram. The shear values are obtained by employing the same mental processes just discussed, but the designer does not stop to construct a large number of individual free-body diagrams.

The forces to the right of any section might just as well have been summed instead of the forces to the left. The answer would be the same. In actual practice it is convenient to sum up the forces on that side of a cut section which can be done most conveniently.

Bending moments and moment diagrams will now be considered. Note Fig. 2*b* again. The magnitude of the bending moment $M$ is wanted at section 1, which is 10 ft. from $A$. The simplest way to define bending moment is to state that it is a force multiplied by a lever arm. If more than one force is being considered, it is the algebraic summation of the values obtained by multiplying each force by its lever arm.

The 45-kip reaction has a lever arm of 10 ft. and produces a moment in a clockwise direction of 45 × 10 or 450 ft.-kips. The 40-kip load has a lever arm of 3 ft. and produces a moment in a counterclockwise direction of 40 × 3 or 120 ft.-kips. The magnitude of the resulting moment is 330 ft.-kips. The sign is positive because it tends to produce clockwise rotation on the right side of the section or to create tension in the bottom fibers in the beam. Another way of defining positive moment is that it tends to sag the beam. Negative moment creates compression along the bottom surface of the beam, tending to hump it. A diving board with a diver at the free end is a good example of a beam under negative bending moment.

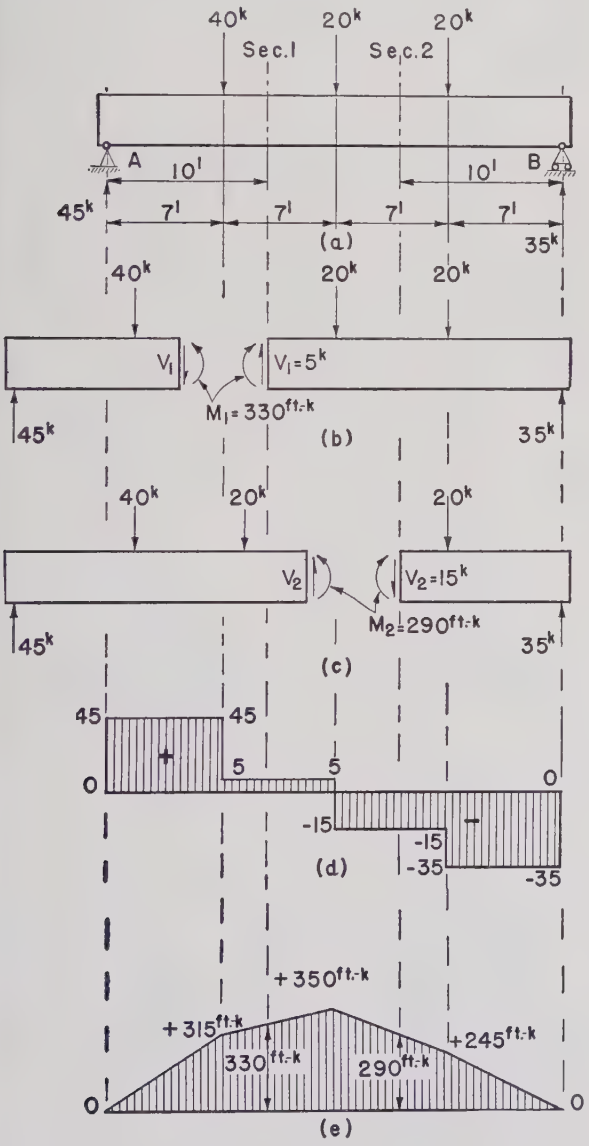



*Fig. 2—DETERMINATION OF SHEARS AND BENDING MOMENTS IN A SIMPLE BEAM*

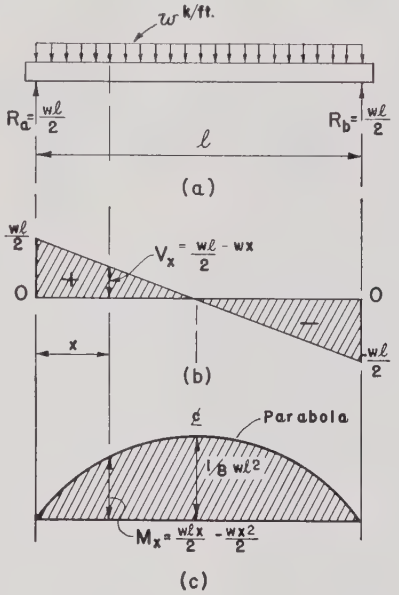



*Fig. 3—ANALYSIS OF A SIMPLE BEAM UNIFORMLY LOADED*

Note section 2 in Fig. 2*c*, 10 ft. from $B$. The bending moment here is 290 ft.-kips. Rather than construct many pictures like Figs. 2*b* and 2*c*, it is more convenient to draw a graph, the bending-moment diagram in Fig. 2*e*. The ordinates give the values of the moments at the various sections of the beam. In this illustration the weight of the beam is neglected.

Figure 2*e* is a characteristic moment diagram for a beam with concentrated loads; it is a series of sloping straight lines. Figure 2*d* is a characteristic shear diagram; it is a series of horizontal lines. Figure 3 shows a simple beam loaded with a uniform load. The moment diagram 3*c* is a parabola; the shear diagram 3*b*, a sloping straight line; and the load diagram 3*a*, a horizontal line.

The slope of the moment curve at a point is the shear at that point. The slope of the shear curve at a point is the load at that point. A point of zero shear is often used to locate the point of maximum moment on a beam.

**Stresses in Simple Trusses.** The simplest truss is a single triangle with three straight bars connected at their ends by frictionless pins and supported as shown in Fig. 4. An inclined load $P$ acting at the upper panel point $U_1$ causes reactions $R_a$ and $R_b$, and develops a stress in each bar with a line of action coinciding with the bar axis. In modern trusses, most joints are riveted or the members are otherwise rigidly connected, as by welding; consequently, the force in a bar will not act exactly in line with the axis. The deviation is so small, however, that in the analysis of trusses it is customary to assume that the position of a member defines the direction and line of action of the stress in that member.

Hence, the only unknown element is the magnitude of the stress.

At this point, the reader should consult Fig. 5 in order to see the distinction between a beam (or plate girder) and a truss. A beam is a solid unit which develops its ability to support loads by its bending resistance and its shear resistance. The truss is an assembly of straight bars joined together in triangular patterns. The loads are resisted by axial forces developed in each bar. In general, trusses are used to carry loads over longer spans than those used for beams and girders.

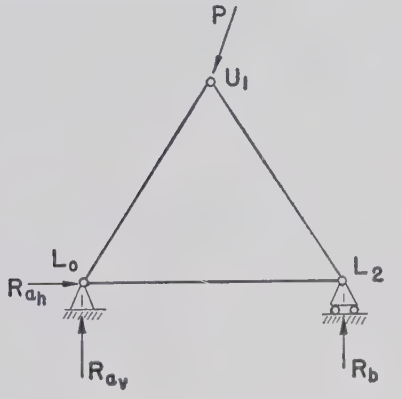



*Fig. 4—ANALYSIS OF A SIMPLE TRUSS*

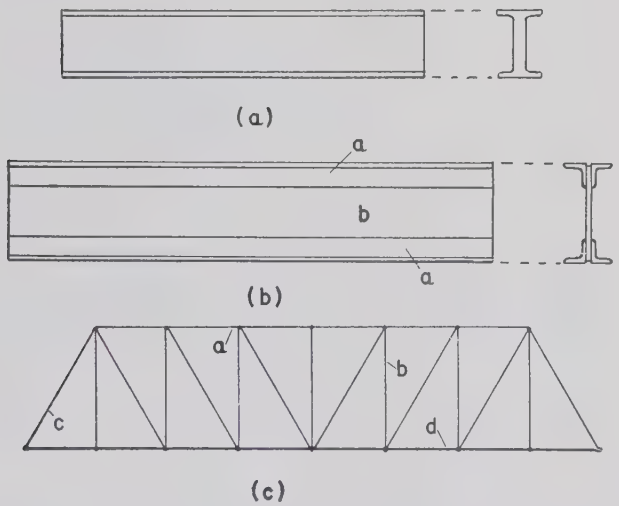



*Fig. 5—DISTINCTION BETWEEN A PLAIN I-BEAM (OR PLATE GIRDER) AND A TRUSS*

*(a) Rolled I-beam; (b) Fabricated plate girder; parts a are flange angles; and part b is the web; (c) Truss; parts shown are: a, top chord; b, vertical; c, diagonal; and d, bottom chord.*

The method of analyzing stresses or forces will now be illustrated by the parallel-chord Pratt truss in Fig. 6*a*. The method of calculating reactions is the same as that used for beams and will not be discussed further. The fundamental equations for the calculation of stresses are the equations of statics, Equations (1), (2), and (3). The procedure of passing sections, cutting bars and internal forces, and separating the truss into free-body diagrams will be used. Sections may be passed in different ways. They may be passed completely around a joint, isolating a concurrent force system, in which the forces intersect at a single point; or they may be passed completely across the truss cutting a nonconcurrent force system, in which the forces do not intersect at a single point. Sections across a truss should not cut more than three unknown bars because only three equations of statics are available.

If the stress in the bottom chord member $L_1L_2$ is wanted, section 1 is passed across the truss, cutting $L_1L_2$ and not more than two additional bars. The left free-body diagram isolated by this section is shown in Fig. 6*b*. Three known external forces are acting on the free body. There are also three unknown forces, $L_1L_2$, $U_1U_2$, and $U_1L_2$. It is not known initially whether they push or pull; in other words, whether they are compression or tension forces.

Equation (3) will be used; and since $L_1L_2$ is wanted, the best selection for the moment center is the intersection of the other two unknown forces at panel point $U_1$. This method eliminates these two unknowns from the equation of moments. The moment of the known external forces about $U_1$ is the reaction of 100 kips multiplied by a lever arm of 24 ft. This tends to revolve the free body with a moment of 2,400 ft.-kips in a clockwise direction around the moment center. The force in the member $L_1L_2$ multiplied by an arm of 32 ft. must supply a balancing moment in a counterclockwise direction of 2,400 ft.-kips. Hence, the stress in $L_1L_2$ equals 2,400/32 or 75 kips. It must be a tension force in order to produce a counterclockwise rotation about $U_1$.

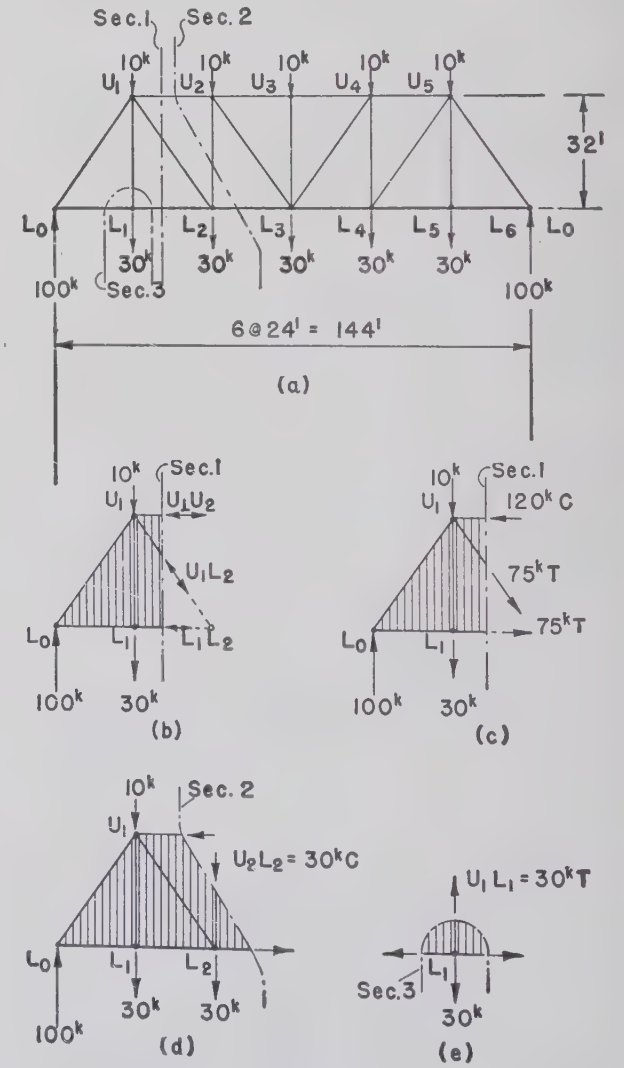



*Fig. 6—DETERMINATION OF STRESSES IN A PARALLEL-CHORD PRATT TRUSS*

Consider the upper chord member $U_1U_2$. It may be determined by taking moments around the panel point $L_2$, the intersection of the other two forces $U_1L_2$ and $L_1L_2$. The moment of the known external forces about this point equals 3,840 ft.-kips, in a clockwise direction. Hence, $U_1U_2$ equals 3,840/32 or 120 kips. The force must push on the cut end of $U_1U_2$ in order to produce a counterclockwise moment and hence is a compression stress.

The same free body is used to get the stress in the diagonal $U_1L_2$. Inasmuch as the upper and lower chords are horizontal, the use of Equation (2) will involve only the unknown force $U_1L_2$. The vertical component of $U_1L_2$ must equal $\Sigma F_y$ of the known external forces acting upon the free body. The total of 60 kips is the reaction of 100 kips upward, minus downward loads of 40 kips. In order to keep the free body from moving upward, the vertical component of $U_1L_2$ must pull downward at the end of the cut bar with a force equal to 60 kips. But the force $U_1L_2$ acts along the inclined axis of the bar and bears the same relation to its vertical component as the length of the bar does to its vertical projection. Consequently, the resultant force is $^{40}/_{32} \times 60$ or 75 kips tension. All the forces acting upon the free body are now determined as shown in Fig. 6*c*.

Sections similar to section 1 may be passed across other panels in order to find the stresses in the remaining bottom chords, top chords, and diagonals.

If the stress in a vertical member $U_2L_2$ is desired, section 2 is passed as shown in Fig. 6*d*. The section is inclined as shown in order to cut not more than three bars. Since the forces in the top and bottom chords cut by this section act along horizontal lines, it is advisable to use the second equation of statics for the bar $U_2L_2$. The resulting equation will then have only one unknown. $\Sigma F_y$ on the free body equals 30 kips acting upward. Hence the stress in $U_2L_2$ is 30 kips acting downward or pushing on the end of the cut bar, thus indicating compression.

The method of obtaining the stress in the vertical member $U_1L_1$ is illustrated in Fig. 6*e*. An inspection of the lower end of $U_1L_1$ shows no inclined diagonals intersecting at joint $L_1$. The only member which can resist vertical forces at that joint is $U_1L_1$. Hence it is convenient to pass a section around the joint $L_1$ isolating a concurrent force system. Equation (2) applied to the system results in a value of 30 kips for $U_1L_1$ acting upward. It pulls on the joint; it is a tensile force.

The preceding illustration of the analysis of truss stresses demonstrates the fundamental procedure. The experienced analyst does not usually take time to draw the free-body diagrams; nevertheless he has them in mind as he calculates the stresses in any type of truss. There are particular arrangements of calculations which greatly facilitate the work involved. Moreover, graphical methods instead of algebraic methods are often used.

**Live Loads and Influence Diagrams.** Influence diagrams are graphs that show the variation in effect at a definite section of a beam or truss due to a single unit load moving across a span. Their primary purpose is to guide the placing of a system of moving loads in order to cause the maximum effect at a particular section. The methods of calculating shears and moments due to loads fixed in position have already been presented. The same procedures are used in obtaining the effects of live loads for any position that they may occupy momentarily in crossing a span. Hence, the basic problem which distinguishes the treatment of live loads from that of dead loads is to find the governing position of the live loads for a particular section. In Fig. 7*a* the position of the crane wheels shown will cause maximum shear at section *d-d* of the beam. A different position as shown in Fig. 7*b* will cause maximum moment at section *d-d*. When another section is studied, two entirely different load positions will cause the maximum shear and the maximum moment.

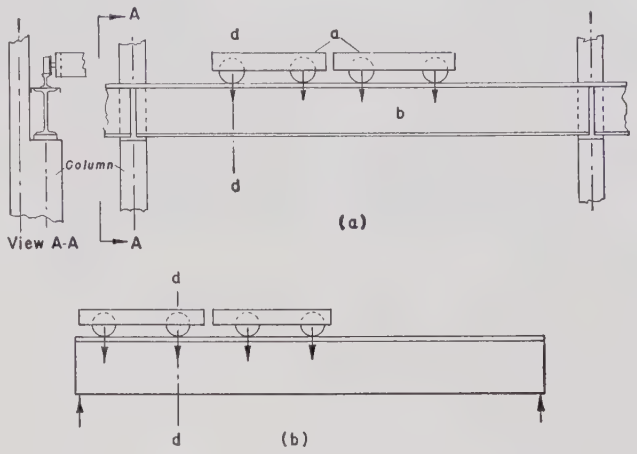



*Fig. 7—FINDING GOVERNING POSITION OF LIVE LOADS*
*In diagram (a), a refers to the moving crane; b, to the crane girder.*

Figure 8 shows typical influence diagrams for the left reaction of a beam, for the shear at section *c*, and for the moment at section *d*. The ordinates of these diagrams give the magnitude of the particular effect at the particular section when the unit load on the beam is vertically in line with the ordinate. All ordinates of the influence diagram for $R_a$ in Fig. 8*b* are positive, thus indicating that a load anywhere on the beam produces an upward reaction at *A*. The diagram suggests that a moving truck, if it crosses the span, should be placed at the left end with the biggest

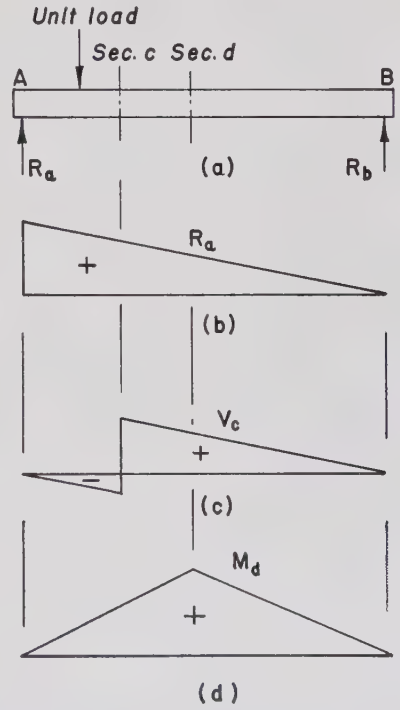



*Fig. 8—TYPICAL INFLUENCE DIAGRAMS FOR A BEAM*

wheel load above the largest influence ordinate. If a moving uniform load acts on the beam, the entire span must be loaded in order to obtain the maximum reaction.

The influence diagram for shear in Fig. 8*c* is partly negative and partly positive. It indicates that the maximum positive shear due to a truck will be caused by placing the truck just to the right of section *c*, with the biggest wheel load at the section. When a moving uniform load

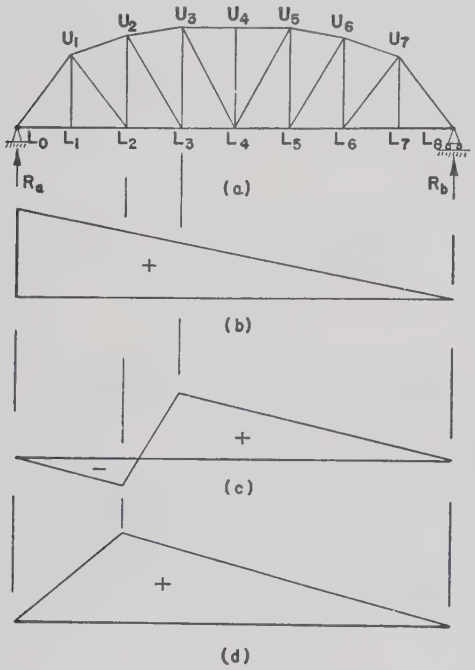



*Fig. 9—TYPICAL INFLUENCE LINES FOR A TRUSS (a) Arrangement of truss; (b) Influence line for reaction* $R_a$*; (c) Influence line for stress in* $U_2\ L_3$*; (d) Influence line for stress in* $L_2\ L_3$

is being considered, only that part of the span between section *c* and the right support *B* should be loaded in order to create maximum positive shear. The influence line for moment at section *d* is shown in Fig. 8*d*.

Figure 9 shows typical influence lines for a truss reaction, for stress in the bottom chord $L_2L_3$, and for stress in the diagonal $U_2L_3$. These lines serve to guide the placing of live loads causing maximum stresses in the particular bars to which they apply. They may also be used to get the final stress in a bar due to a system of loads by multiplying each load by the influence ordinate below the load, and then adding the products to get the total stress.

There are established rules and equations which greatly facilitate the work of the designer in obtaining critical positions for a series of concentrated loads such as those from the wheels of a locomotive; these are detailed in textbooks on the subject.

When maximum live-load shears or moments or stresses are determined for various sections, they must be added to the dead-load effects at the same sections in order to obtain the total values that will govern the design of a beam or a truss.

## STATICALLY INDETERMINATE BEAMS

**The Geometry of Slopes and Deflections.** The geometrical relationships associated with the slopes and deflections of the elastic curve of a beam are important factors in all methods of analysis of continuous structures. Figure 10 shows a two-span continuous beam. There are four unknown reaction components and only three equations of statics. Hence, the beam is statically indeterminate to the first degree.

The deflection curve is shown in Fig. 10*b*. The beam is continuous over the center support. The slope of the tangent to the elastic curve at end *B* of span *AB* is the same as the slope of the tangent at end *B* of span *BC*. This condition supplies the extra equation needed to obtain the reactions and subsequently the shear and the bending-moment diagrams in Figs. 10*c* and 10*d*, respectively.

The fourth equation might also be developed from a consideration of the deflection at support *B*. The zero deflection in the continuous beam is a governing condition. If support *B* is removed and the deflection at *B* is calculated for the simple span *AC* due to the load shown, the result must be equal to the upward deflection at *B* caused by the

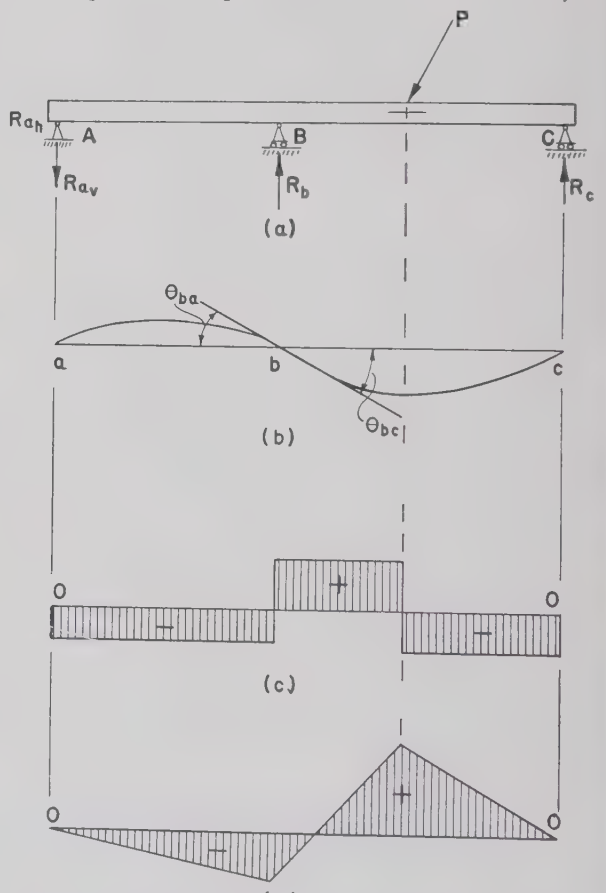



*Fig. 10—DETERMINATION OF THE DEFLECTION CURVE, AND THE SHEAR AND MOMENT DIAGRAMS IN AN INDETERMINATE, TWO-SPAN, CONTINUOUS BEAM* $\theta_{ba}$ *equals* $\theta_{bc}$

replacement of the support or the reaction $R_b$ acting on the simple span *AC*.

Slopes and deflections depend upon the elastic properties of a beam and its loading conditions. They may be quickly obtained from the following moment-area theorems, postulated in 1873 by Professor C. E. Greene:

1. The change in slope between the tangents to the deflection curve of a beam at two points is equal to the area under the *M/EI* curve between the two points.

2. The deflection of any point *B* on the elastic curve of a beam away from the tangent to the curve at point *A* is equal

to the first moment about $B$ of the area under the $M/EI$ curve between the two points.

These theorems lead directly to the auxiliary propositions that the slope of the elastic curve at any point of a simple beam is numerically equal to the shear at the same point due to the $M/EI$ area (from the actual loads) considered as a load on the beam; and the deflection at any point on the beam is numerically equal to the bending moment at the point due to the $M/EI$ area treated as a load. Here, $M$ is the bending moment at any point of the beam due to the actual loads, $E$ is the modulus of elasticity of the material in the beam, and $I$ is the moment of inertia of the cross section of the beam.

**The Moment-Distribution Method.** The moment-distribution method, developed by Professor Hardy Cross of Yale, is probably the most widely used method in the United States for the analysis of continuous beams.

The method starts by making a structure, such as a three-span continuous beam, rigidly fixed at each joint or support and then finding the fixed-end moments for the loading being studied. One joint at a time is then released and the fixed-end moments at that joint are modified until the moments at the joint are balanced. The joint is then fixed temporarily until all other joints have, in succession, been released, balanced, and fixed in their new positions. The procedure is repeated again and again until the desired degree of accuracy is obtained. The process may be vizualized by considering it as a slow-motion picture of the magnified physical response of the structure as it gradually adjusts itself to a load condition which has just been created upon it.

*Fixed-End Moment, Stiffness, and Carry-over Factor.* The fixed-end moment at the end of a particular span is the moment which would exist at that end if it were fixed against rotation. The difference in fixed-end moments at a joint or support is an unbalanced moment; when the joint is released, this moment is distributed to the adjacent members in proportion to their stiffness. Stiffness is defined as the moment necessary to produce unit rotation at one end of the member when the other end is fixed. The rotating end is on unyielding supports. The moment that is distributed to one end of a particular span in proportion to its stiffness causes a moment at the far end of the same span. The ratio of the moment at the far end to the moment at the rotating end is called the carry-over factor.

The fixed-end moment, the stiffness, and the carry-over factor are the three important elements in the process of moment distribution. They are easily derived from the moment-area theorems.

Any case of variable loading on a beam with constant section may be obtained by integrating the expressions for the concentrated load within the proper limits. The stiffness of a beam with constant moment of inertia for its full length is $4EI/L$. The stiffness of a beam with the far end pinned, instead of fixed, is $3EI/L$. Inasmuch as the modulus of elasticity $E$ is usually the same for all spans in a continuous beam, the relative stiffness of each span is $I/L$. The carry-over factor for a beam with constant moment of inertia is $-\frac{1}{2}$.

**Maximum Positive and Negative Moments.** The engineer must design continuous beams for combined dead-load and live-load effects. With influence diagrams as a guide, live loads are placed in different positions to obtain the maximum effects at various sections. From the results of analyses of a number of positions, a series of maximum positive and maximum negative values are obtained and plotted as ordinates along the beam. Envelope curves drawn through these points are termed curves of maximum positive and negative moments.

Initially, values of stiffness are assumed for each span. The first set of maximum moment values are, hence, approximate; they lead to a preliminary design from which more accurate values of stiffness are obtained. The process of calculating maximum moments is then repeated for a final design.

Maximum positive and negative shears and reactions must also be computed before a structure can be completely designed.

**Variable Moment of Inertia.** Most continuous bridges have a changing cross section; consequently, the moment of inertia $I$ in each span is variable rather than constant. The stiffness factors and carry-over factors may be modified considerably for such spans. In fact, if a span is not symmetrical about its center line, the factors at one end will differ from those at the other end. The fixed-end moments will also differ.

There are various methods for calculating the modified factors. Diagrams are also available for certain standardized variations of *I*. *See also* BRIDGES; ELASTICITY; STATICS; STRENGTH OF MATERIALS. H. E. W.

**STRUMA** (Gr. **STRIMÓN**) [stru′mɑ, strimɔ′n], a river, also called the Strymon, rising in the mountains of western Bulgaria, southwest of Sofia, and flowing southward 225 mi. through Macedonian Greece to enter the Gulf of Strimón on the Aegean Sea. It enters Greek Macedonia in the region of the gorge formed by the Belesh Planina and the Perim Dagh of Bulgaria. Near Sérrai, Greece, the Strimón River formerly broadened to form Lake Akhinou, but this lake has been drained and the area is now utilized for the growing of tobacco. The lower Strimón region is quite fertile, producing rice and wine grapes as well as tobacco. S. Van V.

**STRUTHERS** [strʌ′ŧhərz], an industrial city in Mahoning Co., in northeastern Ohio, located 5 mi. southeast of Youngstown. Founded in 1800, the city was incorporated in 1922. The Pennsylvania and the Pittsburgh & Lake Erie railroads provide transportation. The manufacture of steel and its products, such as rods, tubes, and wire, is the most important industry. Pop. 1950, 11,941.

**STRUTT, JOHN WILLIAM (3RD BARON RAYLEIGH)** (1842-1919), English physicist, was born in Essex, England, Nov. 12, 1842. Strutt was educated at Trinity College, Cambridge, and in 1873 succeeded to his father's title. He became professor of experimental physics at Cambridge in 1879 and in 1887 professor of natural philosophy at the Royal Institution. In 1904 he was awarded the Nobel Prize for Physics for the discovery of the element argon, which he isolated in co-operation with Sir William Ramsay, who was awarded the Nobel Prize for Chemistry in recognition of his work on the project. In 1905 Lord Rayleigh became president of the Royal Society and in 1908 was named chancellor of Cambridge University. He died in Essex on June 30, 1919.

The apparent existence of a component of air other than nitrogen and oxygen had been demonstrated in the eighteenth century by Henry Cavendish, who observed that a residue of unknown composition remained after oxygen and nitrogen were removed from the air. In 1892 Lord Rayleigh verified this when, during an investigation of the densities of gases, he discovered that atmospheric nitrogen is heavier than nitrogen prepared by a chemical process. Working from Lord Rayleigh's hypothesis, Sir William Ramsay began

experiments in 1894 involving the combination of nitrogen with heated magnesium. In 1895 Rayleigh and Ramsay jointly issued a paper entitled *Argon, a new constituent of the atmosphere*, which detailed their findings.

Lord Rayleigh had previously postulated electrolytic dissociation in 1884, a year after Svante August Arrhenius published his highly controversial thesis on this subject. He also carried out investigations in optics, on color vision, and in the field of psychical research. Lord Rayleigh received many honors, and held several important offices. H. N. A.

**STRYCHNINE.** *See* PHARMACOLOGY.

**STUART (STEWART or STEUART), HOUSE OF,** a noble family which occupied the thrones of Scotland and England for almost four hundred years. It was founded by Alan of Dol, a Norman baron and a follower of William the Conqueror, from whom he obtained a grant of lands in Shropshire. His nephew, also named Alan, extended the family's holdings when he was given a barony in Suffolk by Henry I of England. His younger son, Walter, established the house in Scotland by entering the service of David I as hereditary steward of the royal household. The line was continued through Walter's great-great-grandson, John, who fought at Falkirk in 1298. Of John's seven sons, the eldest, Alexander, was the forebear of the earls of Angus; the second, Alan, the ancestor of the dukes of Lennox; from the third, Walter, were descended the earls of Galloway; and from the fourth, the earls of Athol, Buchan, and Traquair. John's nephew, Walter, the sixth steward, fought at Bannockburn (1314) and married Marjory, daughter of Robert the Bruce, King of Scotland. Their son, Robert, as regent for David II, was largely responsible for Scotland's recovery from English domination (1338-1341) and succeeded him on the throne in 1371 as Robert II (1371-1390), establishing the Stuarts as royal rulers in Scotland. Others of the Stuart dynasty were James I, famous as a lawmaker and the author of *The Kingis Quair;* James IV, who married Margaret Tudor, eldest daughter of Henry VII of England; and James VI, her grandson and the son of Mary, Queen of Scots, who in 1603 succeeded to the throne of England as James I, thereby uniting the two kingdoms in a dynastic, but not a constitutional union. James's son, Charles I, was executed by the Parliamentarians in 1649, and his children took refuge in exile. However, the Stuarts were restored to power in 1660 in the person of Charles II, but in 1688 his brother and successor, James II, a supporter of the Roman Catholics, was deposed by the nobles of England in favor of his son-in-law William of Orange. Although James fled to France and exile, his two daughters, Mary (1662-1694), wife of William III, and Anne (1665-1714), ruled as queens of England. James II's son, James Francis Edward (1688-1766), the Old Pretender, and his grandson, Charles Edward (1720-1788), the Young Pretender, both claimed the throne of England and led unsuccessful revolts, known as the Fifteen (1715) and the Forty-five (1745), to obtain it. The last legitimate descendant of the Stuarts in the male line, Henry, Cardinal York, a younger son of the Old Pretender, died in Rome in 1807. Several descendants in the female line are living in the twentieth century. A. Jo.

**STUART, LADY ARABELLA** (1575-1615), daughter of Charles Stuart, Earl of Lennox, was next in line after James VI of Scotland, her cousin, to the throne of Queen Elizabeth of England. She was involved in intrigues planned by those who did not want James to succeed Elizabeth. The English queen therefore kept her under close guard. After James succeeded Elizabeth as James I of England in 1603, Lady Arabella professed her loyalty to him, although plots aimed at placing her on the throne continued. In 1610 she secretly married William Seymour, who also had a claim to the throne. They were at once imprisoned but both later escaped. Lady Arabella was recaptured and spent the rest of her life in the Tower of London, where she died, insane, Sept. 25, 1615. E. R. A.

**STUART, GILBERT** (1755-1828), American portrait painter, was born in North Kingston Township, R. I., Dec. 3, 1755. He first studied under the Scottish painter Cosmo Alexander, in Newport, later spending five years as a pupil of Benjamin West in London and twelve years as a successful portrait painter there and in Ireland. By 1793 Stuart had returned to America, and between 1794 and 1796 he painted the portraits of George Washington that have become Stuart's best-known works and the most generally accepted likenesses of Washington; these include the bust-length "Vaughan" and "Atheneum" types and the full-length "Lansdowne" type. Stuart later painted many replicas of these, as well as portraits of other distinguished persons in Philadelphia, Washington, and Boston, where he spent his later years. His finest portraits are characterized by incisive modeling, especially in the faces, vigorous brushwork, and the use of unifying glazes. Among his works are portraits of John Adams, Thomas Jefferson, James Madison, James Monroe, and John Quincy Adams. He died in Boston on July 27, 1828. E. B. S.

**STUART, JAMES EWELL BROWN** (1833-1864), American soldier, was born Feb. 6, 1833, in Patrick Co., Va. He graduated from West Point in 1854, but when the Civil War broke out in 1861 Stuart resigned his commission and accepted a cavalry command in the Confederate Army. He fought at Bull Run in July 1861 and in June 1862 led a spectacularly successful reconnaissance force completely around the Union army massed near the Chickahominy River. His cavalry took part in the Seven Days' Battle near Richmond and the Second Battle of Bull Run, and later in 1862 led the Confederate advance into Maryland. Stuart's troops knifed ahead into Pennsylvania in October to capture and burn the town of Chambersburg. Stuart commanded the Confederate cavalry in the Southern victories at Fredericksburg in December 1862 and at Chancellorsville in May 1863; in June 1863, shortly before the Battle of Gettysburg, he led his troops in a fierce though indecisive battle with Union cavalry at Brandy Station, Pa. Less than a year later, Stuart was mortally wounded in a skirmish at Yellow Tavern, Va., and died in Richmond the next day, May 12, 1864. Considered a genius with cavalry, Stuart was one of the most colorful and popular Confederate officers. W. E. A.

**STUART, MARY.** *See* MARY, QUEEN OF SCOTS.

**STUBBS, WILLIAM** (1825-1901), English historian and prelate, was born at Knaresborough, in Yorkshire, June 21, 1825. Educated at Ripon Grammar School and Christ Church, Oxford, he was ordained an Anglican priest in 1848 and in 1850 received the living of Navestock in Essex, where he commenced those researches which were to make him an outstanding scholar in medieval history. In 1862 he was made librarian at Lambeth Palace, and in the following year he became an editor of the noted Rolls Series, winning his first real success with his edition of the *Chronicles and Memorials of the Reign of Richard I* (2 vols. 1864-1865). As

Regius Professor of Modern History at Oxford, a post he held from 1866 to 1884, his main interest lay in medieval, and especially in constitutional, history. During this period he edited fifteen volumes of English medieval history for the Rolls Series, a magnificent and scholarly achievement. These included *Gesta Regis Henrici II* (1867), and *Memorials of Saint Dunstan* (1874). In 1878, in conjunction with A. W. Haddon, Professor Stubbs published *Councils and Ecclesiastical Documents covering the History of the Anglo-Saxon Church.* It is, however, for his *Constitutional History of England* (3 vols. 1874-1878), together with its companion volume *Select Charters and other Illustrations of English Constitutional History from the Earliest Times to the Reign of Edward I* (1870) that he is most widely known. Although later scholars have pointed out a number of defects in the Anglo-Saxon and Norman portions of this history, and, although his conclusions on parliamentary development are open to criticism, this work still stands as the foundation from which the study of English medieval constitutional history must begin. In 1879 William Stubbs became Canon of St. Paul's and in 1884 Bishop of Chester, an appointment which virtually marked the end of his historical researches, though not of his interest in history. In 1888 he was translated to the Bishopric of Oxford. He died at Cuddesden, Apr. 22, 1901. E. R. A.

**STUPA** [stu′pə], or tope, a mound or tower, commonly hemispherical, used as a Buddhist shrine. Hundreds of stupas or topes exist throughout India and Afghanistan, and many more have been recorded in Ceylon, Burma, Tibet, and China. The earliest stupas were probably erected shortly after the death of the Buddha Sakyamuni in 483 B.C., either to contain relics of the Buddha or to mark places associated with incidents in his life. Legend has it that in the middle of the third century B.C. the Indian emperor Asoka built 84,000 stupas, and it is certain that countless such structures were demolished in more recent times in the constant search for building materials.

The earliest surviving stupa seems to be the Great Stupa at Sanchi, which may have been begun in the Asoka period but which was certainly completed about 75 B.C. This monument displays some of the essential features of the later Buddhist stupas: a hemispherical mound of stone masonry and brick, it has a circumambulatory passage enclosed by a carved stone railing. However, there is no relic casket within the mound at Sanchi, and it also lacks the customary kiosk crowning the mound, to support a shaft decorated with disks that represent symbolic umbrellas.

The stupa form probably originates in the earthen burial mounds common in early periods to many regions of the world, although all surviving stupas are of masonry. They display marked regional and historical variations. For example, the profile of the mound is either hemispherical, bulbous, or conical; some stupas contain no relics, whereas others contain one or more reliquary caskets within the center of the mound, and in some cases the stone railing carved with scenes from the life of Buddha is missing and the drum of the mound has an applied pilaster decoration.

Noteworthy stupas include one at Peshawar, long vanished, which records state was 500 ft. high; the Great Stupa at Sanchi; one at Manikyala whose precise hemisphere is 127 ft. in diameter; and the Shwe-Dagon at Rangoon, 320 ft. in height, built in the eighteenth century. D. N. W.

**STURGEON,** a group of fish having a long fossil history and including the largest, present-day, fresh-water fish known. These large ganoid fish usually live in the sea, but they migrate into fresh water to spawn. Their snouts are long and somewhat pointed; the mouth is inferior and is so arranged that it can be protruded. There are four sensory barbels near the mouth to aid in locating food which is rooted out of the mud bottom. Five rows of bony scutes provide an armor for the long body. Mature adults migrate upstream in the spring to spawn. A large female may lay 3,000,000 eggs. The young stay in fresh water about a year before going to sea. There are about twenty species of

*The common sturgeon,* Acipenser sturio, *a ganoid fish found in the Atlantic region of Europe and North America*

sturgeon in the family Acipenseridae. *Acipenser sturio,* the common sturgeon of both sides of the Atlantic Ocean, was at one time common in the Hudson River but overfishing and water pollution have greatly reduced its numbers. At one time it was so common in the market that its red flesh was jokingly called "Albany beef." *A. huso* is the Russian sturgeon which is the source of the famous caviar. In the Volga River, specimens weighing over 2000 lb. are often captured. *A. transmontanus* is the white sturgeon of the Pacific coast; large specimens (300-600 lb.) enter rivers from Monterey, California, to Alaska. The shovel-nosed sturgeons, *Scaphirhynchus* and *Parascaphirhynchus,* much smaller (5 ft.) than the other sturgeons, are found in the Mississippi River system. The rock sturgeon, *A fulvescens,* is found in that system and in the Great Lakes. E. C. R.

**STURGEON BAY,** a city in northeastern Wisconsin, the county seat of Door Co., situated on Door Peninsula, 130 mi. north of Milwaukee, at the head of Sturgeon Bay, an inlet of Green Bay which is connected with Lake Michigan by a ship canal. It lies in the heart of the great cherry-growing districts of the country. The scenic beauties of the peninsula have also made it a popular resort. In addition to tourism and the industries connected with the cherry orchards, the commercial and industrial activities of the city include quarrying, shipbuilding, the handling of water freight, and fishing. On the outskirts of the city are a state fish hatchery and a branch of the University of Wisconsin's Agricultural Experiment Station. The first white man known to have passed through this area was Father Jacques Marquette in 1673. Sturgeon Bay was incorporated as a city in 1883. The city is governed by a mayor and council. Transportation is provided by the Ahnapee and Western Railway. Pop. 1950, 7,054.

**STURGEON FALLS,** a town in Nipissing District, Ontario, Canada, situated on the Sturgeon River, 3 mi. north of its entry into Lake Nipissing, and 24 mi. west of North Bay, on the Canadian Pacific Railway and Provincial Highway 17. A large paper mill is located in the town. In addition to the fishing industry, which is important, there are cooperage-stock and optical-abrasive factories. The surrounding region contains many tourist resorts. Pop. 1951, 4,962. D. F. P.

**STURGIS** [stɜ′rjɪs], a city and lake resort in southwestern Michigan, in St. Joseph Co., situated close to the Indiana border, 34 mi. south of Kalamazoo. The surrounding area is a fertile, diversified-farming district.

Founded in 1827, Sturgis was incorporated as a city in 1896. A manager and council administer the city, which lies in a district that was once famous Indian territory and a stronghold of the Potawatomi Indians. In the near vicinity is the junction of the Great Sauk Trail and the Nottawaseepe Trail. Transportation is afforded by the Pennsylvania and the New York Central railroads. Sturgis ranks among the first four cities in the state in the manufacture of furniture. Other manufactures include sales-record books, surgical elastic bandages, draperies, novelty paper products, hardware, brass specialties, and Venetian blinds. Pop. 1950, 7,786.

**STURGIS,** a city of western South Dakota, the county seat of Meade Co., situated in the Cheyenne River watershed area, 28 mi. northwest of Rapid City. Lying in a valley of the Black Hills, surrounded by an area noted for its cattle raising and farming, it is a market center for livestock, grains, and poultry. There are gold deposits in the region. Founded in 1878, when General Sheridan established Fort Meade on this site, Sturgis was incorporated as a city in 1888. The local government is of the mayor-councilmanic type. Sturgis was an important stop for the famous Deadwood stagecoach. Features in the vicinity are the Black Hills; the historic Indian shrine at Bear Butte; Rainbow Cliff, a brilliant geological formation; and the site of the famous Fort Meade Cavalry Post. The historic fort was turned over to the United States Veterans Administration in 1944, and in 1950 the Administration opened the Fort Meade Veterans Hospital there. Transportation is furnished by the Chicago and North Western Railroad. Lumbering is the principal local industry. Pop. 1950, 3,471.

**STURLUSON, SNORRI** [snɒ'rrɪ stɜ'rlɜsɒn] (1179-1241), Icelandic historian, poet, and chieftain, was born in Hvammur, Dalir, west Iceland. He was a member of an ambitious family of good stock, which in the first half of the thirteenth century made a bid for power in Iceland but lost out to more realistic opponents in alliance with King Haakon IV of Norway. Snorri was brought up in Oddi, a center of learning in southern Iceland, which was established by Saemund the Learned (1056-1133). In Oddi, Snorri studied law, poetry, and history, and thereafter he became a wealthy chieftain in Borg and Reykholt. He was killed with the king's connivance at his home in Reykholt, Sept. 22, 1241.

Snorri was the author of two outstanding works of Icelandic literature, the "younger" *Edda* and *Heimskringla.* He wrote poems in praise of at least three kings and two earls, but all that remains of these eulogies is the *Háttatal* section of his *Edda. Heimskringla* is composed of historical material that he collected on a trip to Norway and Gotland between 1218 and 1220. Besides these important works, he may have written *Egils saga,* the story of his famous poet-ancestor, Egill Skallagrímsson.

As a chieftain, Snorri was ambitious and shrewd, but he lacked courage and the cruelty that the times required. He loved splendor, was a lavish host, and shows in his writings that he was a dignified man of the world. As an artist he was fully equal to the best saga writers, and the modern historian Halvdan Koht has called him the foremost historian of the Middle Ages. *See also* EDDA, THE YOUNGER; HEIMSKRINGLA.

S. E.

**STURM, JACQUES CHARLES FRANÇOIS** [stü'rm] (1803-1855), French mathematician of German ancestry, was born at Geneva, Switzerland, Sept. 29, 1803. Sturm showed signs of genius at an early age. Before he was fourteen, he had completed the Geneva College course; he then studied at Geneva Academy and when only twenty-four received the grand prize in mathematics for his work on the compression of liquids. Sturm lived most of his life in Paris, where as a very young man he tutored the son of Madame de Staël. In 1829, then only twenty-six, he established his numerical equations theorem, famous throughout the mathematical world. In 1836 he was elected to the Académie des Sciences and in 1840 became a professor in the Ecole Polytechnique, where he shortly succeeded Siméon Poisson. Sturm's work, *Cours d'analyse de l'École polytechnique* (1857), was published posthumously. He died in Paris, Dec. 18, 1855.

A. S. M.

**STUSS.** *See* CARD GAMES.

**STUTTERING,** sometimes called stammering, is a form of anxiety tension, manifested as a disturbance in the fluency of speech, motivated by an apprehensive anticipation of difficulty in initiating or maintaining an adequate flow of speech.

Pertinent surveys indicate that nearly 1 per cent of American school children stutter. According to Prof. Charles Van Riper, Dr. C. S. Bluemel, Dr. Emil Froeschels, and other authorities, stuttering generally begins in early childhood and nearly always consists of easy, simple repetitions and hesitations in its early stages. This general view has been confirmed and elaborated by studies reported from the State University of Iowa Speech Clinic, which indicate that the average age of onset of the difficulty is three years. The studies also indicate that children who develop stuttering do not differ as a group from nonstuttering children so far as intelligence, health, physical development, speech development, and general behavior are concerned. It is of particular importance that stuttering is usually originally diagnosed by laymen, usually the parents. What they diagnose as stuttering appears in the usual case to be indistinguishable from the ordinary repetitions and hesitations in the speech of normal young children, between the ages of two and five, who have been found to average 45 repetitions per 1,000 words.

As to treatment, there is general agreement that stuttering should be treated as a form of anxiety tension. The main objective is to reduce the anxiety or fear regarding stuttering, and by this means, and in direct ways also, to reduce the hesitancy and tension characteristic of the stutterer's speech. Mental hygiene, or personality re-education, also is indicated in many cases to counteract the maladjustive effects of stuttering. The treatment of young children is chiefly a matter of parent education designed to change the parents' evaluations of the child's speech, and the accompanying parental policies, so as to remove the sources of the child's anxiety tension, which may be harmfully increased by parental demonstration of concern or by actually instructing the child to stop and start over, to speak more slowly, or to stop and think.

W. J.

**STUTTGART** [shtu'tgart], an industrial and commercial city and capital of the state (*Land*) of Baden-Württemberg, in the southwestern part of the (West) German Federal Republic, about 40 mi. southeast of Karlsruhe. Between 1945 and 1951 it was the capital of the *Land* of Württemberg-Baden, one of the three component parts of the present state. The city lies among hills with its center a short distance west of the Neckar River and with the suburb of Bad Cannstatt on the river's east bank. First mentioned

in 1229, Stuttgart was after 1265 the favorite residence of the counts of Württemberg, became their capital in 1482, and developed rapidly as an industrial center in the nineteenth century. Between 1903 and 1929 thirteen suburbs, including Cannstatt, were incorporated into the city. Stuttgart was severely bombed in World War II, resulting in extensive damage to the city and its industries. Most of the city was built in the nineteenth century and presents a modern appearance, in so far as it survived World War II. Many of its noteworthy buildings were bomb-damaged, including Stifts Kirche, or Church of the Holy Cross, built between the thirteenth and fifteenth centuries, which was completely ruined; the sixteenth-century Old Palace, gutted and partly destroyed; and the eighteenth-century baroque New Palace, also gutted and partly destroyed. There are several fine squares and parks, including the 200-acre Palace Garden. Though generally damaged, buildings of note include the fifteenth-century St. Leonard's Church, the academy, the former Royal Library, the museum of art, and the polytechnic school. Stuttgart is the center of the economic life of Württemberg and of the southern German publishing trade. Its surrounding hills are dotted with vineyards and orchards. The city is an important rail junction, and its industries include the manufacture of electrical equipment, machinery, textiles, iron, motor cars, furniture, pianos, optical equipment, leather and metal goods, chemicals, beer, and foods. Pop. 1953, 566,000. C. C. H.

**STUTTGART** [stʌ′tgɑrt], a city in east central Arkansas, the county seat of Arkansas Co., situated in a prairie and agricultural area, 45 mi. southeast of Little Rock. Founded in 1879, it was incorporated as a city in 1887. The city government is of the mayor-councilmanic type. Transportation is furnished by the St. Louis Southwestern and the Chicago, Rock Island and Pacific railroads. Industries include the milling of rice, grown in the vicinity, and the manufacture of pumps and well drills. Pop. 1950, 7,276.

**STUYVESANT, PETER** [stai′vəsənt; stɔi′vəsɑnt] (1592-1672), Dutch colonial administrator, was born in West Friesland, the Netherlands, in 1592. In 1635, after several years of military service, he was employed by the Dutch West India Company, and in 1643 became governor of Curaçao and adjacent Dutch islands. As a result of a wound received in an attack in 1644 on the island of St. Martin, Stuyvesant lost his right leg and was forced to return to Holland to recuperate. The wooden leg he wore thereafter was decorated elaborately with silver bands and became known popularly as his "silver leg." In 1646 he sailed again to the New World as the Dutch West India Company's appointee to the director-generalship of New Netherland. Upon his arrival in New Amsterdam (later New York) on May 11, 1647, he inaugurated an administrative policy so bluntly assertive of the interests of his company that he alienated the sympathies of many of the local burghers. At a meeting with the New England Commissioners in Hartford in 1650, Stuyvesant settled a dispute of long standing by coming to a definite agreement on a boundary between Connecticut and New Netherland. In 1653 he established for the city of New Amsterdam a plan of municipal government closely patterned on that of the cities of Holland. During the next ten years, Stuyvesant's efforts failed to prevent the decline of Dutch influence on Long Island, but he fought back the Swedes, especially in the vicinity of what is now Newcastle, Del., and he kept the Indians under close restraint. In 1664 an English fleet appeared in the bay and demanded that the city capitulate to the Duke of York, who lay claim to all the land between the Connecticut River and Delaware Bay. Stuyvesant's plans for defense were opposed by the local burghers, and on Sept. 3, 1664, New Amsterdam was surrendered to the English. Stuyvesant went home to Holland in 1665 to defend himself against charges of misconduct. He retired to New York in 1667, and lived on his farm or *bouwerij,* from which New York City's Bowery takes its name, until his death in February 1672. He was buried in the vaults in Saint Mark's Church. M. K.

*PETER STUYVESANT*

COURTESY OF THE AMERICAN MUSEUM OF NATURAL HISTORY

**STYLITES, ST. SIMEON.** *See* Simeon Stylites, St.

**STYRIA** (*Ger.* **STEIERMARK**) [stɪ′riə, shtai′ərmɑrk], a province in central and southeastern Austria. A generally mountainous region with an area of 6,326 sq. mi., Styria is divided into three main geographical regions: the Upper Highlands, Central Styria, and Southern Styria. The Highlands, notable for its mountains and lakes, is a district of heavy industry, including iron and steel works in the valleys of the Mur and Mürz; an iron center near the Erzberg, a mountain of iron ore; and salt mines at Bad Aussee. Central Styria is less rugged than the Highlands, and Southern Styria is given over to fruit growing and vineyards. Styria produces the greater part of Austria's brown coal; timber is an important resource, and there is an abundance of hydroelectric power for manufacturing. The chief towns are Graz, Leoben, and Bruck. Graz is the provincial capital and Austria's second largest city.

The duchy of Styria was originally part of the larger duchy of Carinthia, and was a portion of the inheritance of Ottokar II of Bohemia, who was ejected from Lower Austria in 1278 by Rudolph I of Hapsburg, Holy Roman Emperor. Through marriage, both the duchy of Styria and the kingdom of Bohemia formally became Hapsburg crownlands. The subsequent history of Styria is inseparable from that of Austria. Following World War II the province was in the British occupation zone until the occupation of Austria was ended by the treaty signed May 15, 1955. Pop. 1951, 1,109,335. S. Van V.

**STYRON.** *See* Plastics (*Commercial Plastics*).

**STYX** [stɪ′ks], the "abhorrent" river, which in Greek mythology was considered the principal river of the underworld, around which it flowed seven times. Personified, Styx was described as a daughter of Oceanus and Tethys; she assisted Zeus against the Titans and was rewarded by

having the most solemn oaths sworn by her waters. Not even the gods dared to swear falsely by the river Styx. The Styx was also the name of a small stream in Arcadia, the waters of which were believed poisonous. G. E. D.

**SUBCONSCIOUS,** a psychiatric term to designate what James called our "other selves," or the state between the conscious and unconscious.

Freud regarded the subconscious as a level of psychical activity just below that of conscious awareness, in which material normally recallable and at the mind's "finger tips" is stored and can only be remembered or called to the conscious level by active and vigorous attempts to muster one's forces of mnemonics. In an attempt to avoid confusion over terminology, psychiatrists in recent times have favored the expression "fore-conscious," which they describe as an element of the mind which contains latently unconscious material, but which can be recalled by the individual himself. The concept of the subconscious implies a bit of instinctual behavior, habit training, and racial heritage.

This latter consideration led Karl Jung to modify Freud's psychology in the treatment and analysis of the concepts of consciousness and to postulate the personal unconscious and the collective or racial unconscious. The former consists of ontogenetic experiences, not retained in consciousness, but repressed as painful, unpleasant, or unsuitable. This material may gain conscious expression in dreams, slips of the tongue, or action. The collective or racial unconsciousness is the heritage of the entire racial past, the universal substratum common to all humanity. It is the historical background from which every mentality has evolved. Traces of experiences lived through ancestrally—phylogenetic—are engraved on the mind. J. A. Br.

**SUBJECTIVISM,** a term used broadly to emphasize the role played by self or mind in experience; or to stress the role of human in contrast to extra-human facts.

In metaphysics, subjectivism is the view that only subject, mind, or human experience is real or is the source of real things. Extreme subjectivism, illustrated in solipsism, holds that the individual self is the only reality.

In epistemology, modern subjectivists have advanced the following theories of knowledge: (1) that the criteria for knowing the external world with certainty, e.g., "clear and distinct ideas" (Descartes), are found within the mind itself; (2) that the only objects known, ideas, are themselves within the mind so that the world as known is the subject's presentation (a view held with reservations or inconsistent factors by Locke, Berkeley, and Hume); (3) that the subject is a windowless whole of experience, a "monad," which reflects, or is a representation of, reality (Leibniz); (4) that the subject provides the forms of perception (time and space) and the categories of understanding (e.g., cause, plurality) which are imposed upon our sense experience of the external world (Kant); (5) that an individual's belief constitutes knowledge if it "works satisfactorily in the widest sense of the word" in human experience (pragmatism).

Regarding values other than truth values—moral, æsthetic, religious—subjectivism is the doctrine that values are created by, limited to, or interpreted by the individual wholly in terms of factors in his own experience—imagination, will, or feeling—so as to provide him with a feeling of happiness, pleasure, or satisfaction. H. Bn.

**SUBLIMATION.** *See* Changes in Matter; Psychoanalysis (*Mental Mechanisms*).

**SUBMARINE,** a boat or like device, other than a diving suit or helmet, which enables men to descend under water, remain there an appreciable time, and return to the surface. Typically, it is a watertight, self-propelled craft, strengthened to resist depth pressure, fishlike in shape, achieving submergence primarily by admitting water to ballast tanks and so neutralizing its own buoyancy. A distinction has been drawn between submersibles, which are surface craft capable of submerging, and submarines, vessels operating exclusively or mainly under water. In this sense, the submarine has only within the present century become a practical reality.

### THE BASIC PROBLEMS

How far back the urge to live, move, work, and fight under water goes we cannot tell, but there is evidence that it was a matter of interest over 2,000 years ago. This is true not only of the inclination to dive and swim, with or without artificial diving dress and breathing equipment, but of the desire to descend in boats or boatlike vehicles—in short, by submarine.

Before any real progress could be made toward inventing the submarine as we know it today, there were major theoretical and mechanical problems to be solved. How could a boat or chamber be made to sink below the surface and yet return to it? What would be the effect of the pressure at great depths? How could a vessel be propelled from place to place under water or be kept on an even keel? How could the submarine navigator see where he was going, or steer? How were the boat's occupants to breathe? Behind these problems lay the basic properties of water itself, of floating structures, and of human anatomy, which established the framework within which submarine science must develop. Though they seem fairly obvious today, many of them were perceived only gradually, as the results of experiment, the experimenter not even being aware that such problems existed until they were encountered, perhaps with fatal consequences. Sometimes, the problem was recognized and solved in theory many years before it was overcome in practice. The mathematicians and philosophers of antiquity established a number of the fundamental principles of the submarine 2,000 years before human need compelled or technology permitted their application.

**Buoyancy.** Sea water weighs 64 lb. per cu. ft. Any object—including a watertight vessel and the air it contains—which weighs less will displace only its own weight of water and remain afloat; it has positive buoyancy. Any object which weighs more than 64 lb. per cu. ft. will displace its volume of water and sink; it has negative buoyancy. If a hole is poked in a ship's steel hull so that inrushing water replaces its air content, the vessel will become heavier than water and go down. Its positive buoyancy becomes negative. This, in oversimplified form, is how a submarine submerges.

The submarine, unlike the punctured hull which goes to the bottom and stays, must be able to stop part way down and to resurface. To do this, it must take advantage of another property of water, its pressure. Since a cubic foot of water weighs 64 lb., a box measuring 12 x 12 x 12 in. will have 64 lb. of pressure on its top at a depth of one foot. However, the pressure on its bottom, which is 2 ft. down, will be doubled or 128 lb. The difference between the pressure on the top and that on the bottom is 64 lb. If the box has positive buoyancy, this difference will push it to the surface; if it has negative buoyancy, it will not prevent its sinking. But, if just enough water can be admitted to the box to give it and its contents a weight of 64 lb., it will have neutral buoyancy

and will remain suspended at any depth, without rising or sinking.

A submarine is subject to the same rules as the box. It submerges by the controlled admission of water to its tanks; it remains at a given depth by achieving neutral buoyancy; it resurfaces by expelling enough water to regain positive buoyancy.

Submarine hulls must be of great strength. With pressure increasing at the rate of 64 lb. per sq. ft. for every foot of descent, it does not take long for water to build up a force capable of crushing most man-made structures, not to mention human beings themselves. Men descending into deep water in diving suits must be given compressed air to breathe or the difference between internal and external pressure will crush them to death. In a submarine they do not need this precaution, for the boat's main or "pressure" hull must be strong enough to resist the pressure at any depth to which it may descend.

**Steering and Stability.** Control and direction of a submerged vessel involve different problems and, therefore, different methods from surface craft. The latter need only be steered to right or left; the submarine must also be steered up and down. Hence, it must have horizontal rudders or "diving planes," as well as the conventional vertical rudder. Most important, the submarine must be provided with a means of keeping it on an even keel at any depth, for diving planes alone cannot do this. A submerged vessel responds much more freely to any shift in its longitudinal center of gravity than one floating on the surface. It was not realized for many years that the chief hazard in this respect was the ballast tanks by means of which a submarine was enabled to submerge.

Anyone who has tried to carry water in a wide, shallow pan knows how abruptly it will rush to one side at a slight deviation from the horizontal. The same phenomenon, on a large scale, occurred in the tanks of many early submarines, which were generally filled only as far as was necessary to submerge the boat. This usually left an extensive free surface in the tanks, which permitted the water to slosh and impaired the vessel's longitudinal stability. At any small shift in its center of gravity, the water in these tanks would rush to one end, often throwing the whole boat into such an extreme nose-dive or tail-dive that no amount of engine and rudder power restored her to the horizontal.

**Vision.** Though it is a transparent substance, sea water is usually not easy to see through. Daylight in useful quantity penetrates only a few feet below the surface, as a rule, and even powerful artificial lights are helpful only at close range. Glass observation ports, therefore, have never been of much use to a submarine under water. John Holland, an American submarine inventor, reported that they were of no real assistance in guiding his early boats; a surface vessel floating close overhead was nothing but "a dark shadow." (Probably the most fantastic feature of Jules Verne's *20,000 Leagues Under the Sea,* even today when much of its fiction has become fact, is the provision of windows through which his submarine voyagers might gaze out upon wide sea-bottom landscapes.)

The only way by which early submariners could see where they were going was to surface the submarine so that they could peer through its portholes, as in the case of Holland's vessels, or to come near enough to the surface to use a periscope which was raised above the surface of the water. At present, electronic instruments tell a navigator many fathoms below the surface all he must know about the surrounding water and its occupants.

**Ventilation.** Since men must have air to breathe, there was a deep-rooted fear of suffocation if one went under water in any sort of sealed vessel. Some actual and proposed submarines, even at the end of the nineteenth century, were provided with flexible air hoses supported by floats on the surface or with hollow masts. In point of fact, the hazard may have been slightly overrated. Men normally inhale air containing 20 to 21 per cent oxygen and exhale air containing about 16 per cent, the balance of the oxygen being replaced by carbon dioxide. At this rate, the oxygen supply in even a small sealed chamber will last quite a while. Actually, it is the build-up of carbon dioxide in the air, rather than oxygen exhaustion, which is dangerous. Since World War II the atmosphere of submarines has been kept fresh with a $CO_2$-absorbent, lithium hydroxide.

More than 150 years ago, compressed air was first used to allow men to remain under water at least until the tanks or bottles were exhausted. Compressed air recently has become a necessity not only for breathing, but also for blowing water from the ballast tanks for surfacing, and an air compressor is now standard equipment on submarines. The latest submarines also carry oxygen tanks to replenish the air for breathing.

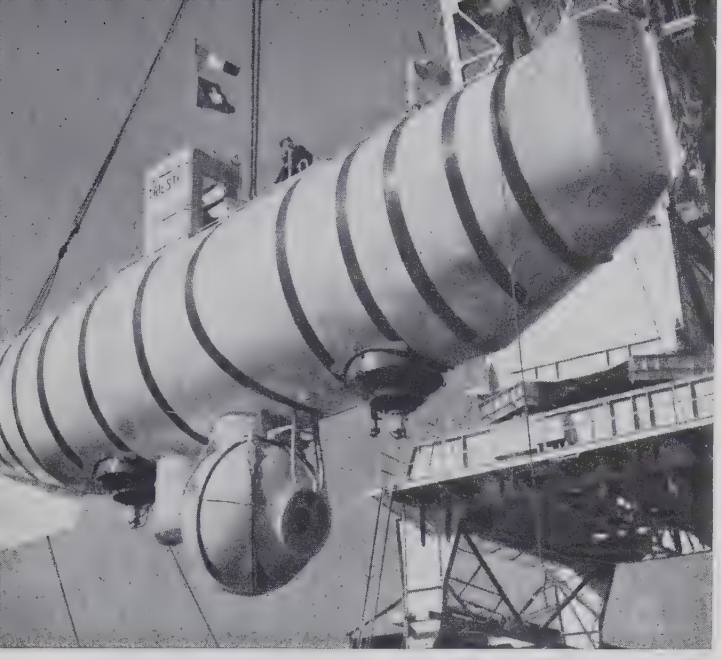
## EARLY SUBMERSIBLES

**Diving Bells and Diving Chambers.** The simplest way to go under water dryshod is to be lowered in some sort of container which like an anchor sinks because it weighs more than the water it displaces and which returns to the surface solely because it is hauled up. The container may be completely watertight; it may be open at the bottom so that a supply of air remains trapped within it, the water rising into it only to the extent that the pressure at any given depth compresses the trapped air. In the first instance, it is a prototype of the bathysphere; in the second,

BURGUNDY LIBRARY, BRUSSELS, BELGIUM

*HOW ALEXANDER LOWERED HIMSELF INTO THE SEA IN A GLASS BARREL*

FROM A MANUSCRIPT OF THE THIRTEENTH CENTURY



WIDE WORLD PHOTOS

*The bathyscape Trieste being lowered into the sea. Prof. Piccard and his son ride in the steel ball at the bottom.*

of the diving bell. Though the evidence is not explicit, it appears that both these types of submergence chamber were known and used in ancient times.

*Diving Bells.* Aristotle speaks of the use of diving bells in the 4th century B.C., and Pliny alludes more vaguely to diving equipment. Early Greek sponge divers are said to have utilized the diving bell principle by submerging large inverted jars near their working ground and ducking their head into them for a periodic gulp of air. A pre-Christian, watertight diving chamber is the "glass barrel" in which, according to legend, Alexander the Great submerged to satisfy his curiosity about undersea life.

During the Renaissance, experimentation with diving bells continued. Roger Bacon and Leonardo da Vinci are both credited with underwater devices. A "notable diving bell" was tried at Toledo, Spain, in 1538. About 1640, a submarine "packet" invented by John Barrié was reportedly used in salvage work at Dieppe, France.

At the start of the eighteenth century, Dr. Edmund Halley of comet fame perfected a device which may be called the first fully successful diving bell. It was built of wood and enabled five occupants to remain 60 ft. under water "above an hour and a half" by virtue of an air-supply system consisting of two barrels, one of which was filled with air at the surface and lowered as the other was pulled up. Increasing pressure on the descending barrel pumped its air content into the bell through an oiled leather hose, while Halley released stale air from a valve at the top.

Except for the absence of compressed air, Halley's invention set the pattern for the modern diving bell. With compressed air added, water could be prevented from rising in the bell as hydrostatic pressure increased. The caisson, which is fundamental to all present-day underwater construction and excavation, is simply a specialized, outsize diving bell in which air pressure is employed to keep out water and provide a dry working area. Another modern version is the nautilus (a name of frequent occurrence in submarine literature). This is a self-controlled, nonsuspended bell, partaking of the character of a submarine boat. It is sunk by admitting water to its outer chambers, but its buoyancy may be so regulated that, in still water, workmen inside can move it in any direction by pushing.

A bridge between the submarine and the diving bell is the series of at least 14 boats built on the Mississippi system between 1840 and 1870 and named *Submarine No. 1, Submarine No. 2,* etc. They were not in themselves submersibles but paddle-wheel steamers incorporating diving bells. The invention of James B. Eads, they were used in the salvage and removal of wrecks and other obstacles to navigation. One, *Submarine No. 7,* was later converted to the gunboat *Benton* during the Civil War.

*Diving Chambers.* While the diving bell was ideally suited to underwater salvage, construction, and demolition work, the watertight chamber was much better adapted to scientific exploration of great ocean depths. Alexander's glass barrel, however, would scarcely have served William Beebe and Otis Barton on their 35 deep dives off Bermuda in the early 1930's. They employed the bathysphere, a hollow steel ball about 5 ft. in diameter, designed to endure enormous pressures without collapsing and suspended by cable from a surface vessel. Electrical connections powered its oxygen-circulating system and 2,600-candlepower searchlight by whose beam, through peepholes of three-inch fused quartz, Beebe and Barton observed the nearby ocean life. In their record dive the two men were able to reach a depth of 3,028 ft.

Far greater depths have lately been attained by European scientists using a bathyscape, which resembled the bathysphere in that its passengers rode in a spherical steel chamber, much more heavily constructed. It was not, however, suspended from a surface vessel but attached, like the gondola of a blimp, to a free-floating tank filled with a liquid much lighter than water and, hence, buoyant. Heavy metal ballast attached by electromagnets sank this "submarine balloon" to the desired depth and, when released, permitted its return to the surface. The bathyscape was designed by Professor Auguste Piccard, who on Sept. 30, 1953, descended into the Mediterranean with his son to a depth of 10,330 ft. The following February, Georges Houot, an officer of the French Navy, reached a depth of 13,284 ft. in a similar device in the Atlantic.

A specialized diving bell with certain characteristics of the submarine is the McCann rescue chamber, first used with great success to save the survivors of the sunken U.S. submarine *Squalus* in May 1939. Ten ft. high and 8 ft. in diameter at its widest, it is divided by a hatch into upper and lower compartments. Ballast tanks and compressed-air connections permit buoyant control while it is being lowered and raised by the salvage vessel. The rubber-gasketed skirt of the lower compartment fits snugly on the standard escape-hatches built into all modern American submarines. *See also* SUBMARINE RESCUE CHAMBER.

**Early Submarine Boats.** As with most other technical innovations, it is impossible to say of the submarine that a particular person invented it at a particular date. Assorted craft, having some of the submarine's characteristics, were devised over more than three centuries. In fact, the revolutionary advances being made today suggest that the submarine may not have been fully "invented" yet.

Early in the sixteenth century, Oalus Magnus, Bishop of Uppsala, reported having seen submersible leather boats which had been captured from pirates who used them to sink passing merchantmen. Whether he was looking at the first real submarine or aboriginal kayaks is a matter of some doubt. In 1573, William Bourne planned a submerging boat which, if built, would have embodied ingenious solutions to the problems of buoyancy and ventilation. It was to have a "double hull"—a vented leather skin enclosing an

inner shell of wood—and to receive or expel water ballast as screw jacks distended or contracted its sides. A hollow mast reaching above water was to supply air.

The earliest circumstantial reports of a vessel navigating below the surface concern a wooden rowboat decked over with watertight leather. It was built by Cornelis Drebbel and used on the Thames River between 1620 and 1624. Propelled by oars working through leather seals, it made trips "several hours" long at a depth of 15 ft. King James I is said to have ridden in it. Although there is ample proof of its existence and the great public interest it evoked, there are no surviving technical data on Drebbel's invention. We do not know how he submerged, how he steered, or how the vessel got air. Contemporary accounts speak cryptically of his carrying a vessel of "chymical liquor" which he could uncork to purify the air when it became "troubled."

Another seventeenth-century submarine, the "Rotterdam Boat" of the French inventor De Son, is significant because she was designed for military use, unlike Drebbel's. Built of wood, the Rotterdam boat was 72 ft. long and was propelled by a paddlewheel midship. Despite reportedly successful trials, De Son could interest neither the Dutch nor the French in using his invention against the British.

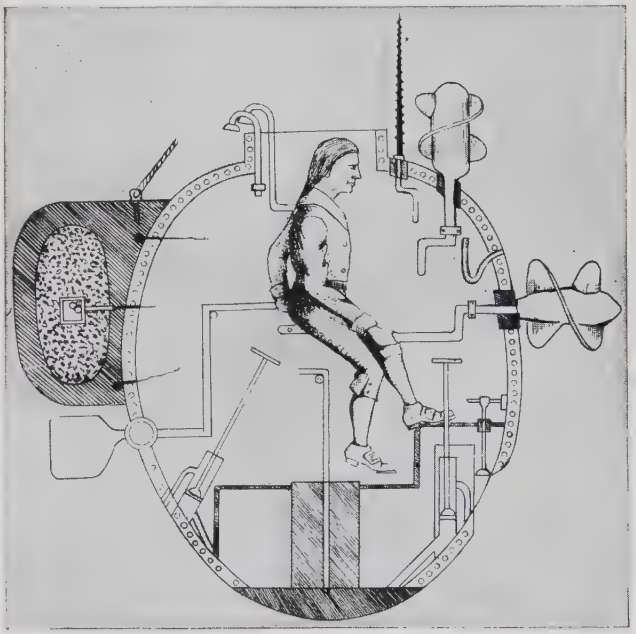
Striking gains in submarine technology were made in the eighteenth century and, by its end, several basic problems had been solved or their solutions were clearly foreshadowed. About 1730 an Englishman named Symons developed a French idea formulated 50 years earlier. He installed in a decked rowboat a crude prototype of the ballast tanks which modern submarines fill to submerge and blow to surface. Symons' tanks were leather bags with necks opening through apertures in the bottom of the boat. To raise his vessel, he squeezed the water out of the bags by leverage and tied their necks.

*The Turtle.* Two months after the Declaration of Independence was signed in 1776, the first American submarine made the first recorded underwater attack on an enemy vessel. The *Turtle,* designed and built by David Bushnell of Connecticut, attacked the British frigate *Eagle* anchored in New York Bay. In form, the *Turtle* was unique. Built of oak and shaped like a coconut, she stood on end in the water instead of lying flat. A brass conning tower—the submarine's equivalent of a pilot house or navigating bridge—was located on the upper side of the vessel. It was of the most rudimentary sort, being simply a raised circular hatchway with several small glass peepholes set into its sides. The one-man crew sat with his head projecting into the conning tower so that he could look out through the portholes when the *Turtle* was awash. At the lower end of the coconut was a quantity of lead ballast, part of which was external and detachable, and tanks which could be flooded by a pedal valve and emptied by a force pump. Buoyancy could thus be controlled so that the *Turtle* neither rose nor sank in the water. Horizontal movement could be achieved by cranking one small propeller on the screw principle; vertical movement, by turning another. There was no underwater air supply. Since air was admitted only when the vessel was awash through valves which closed automatically if water overflowed them, the *Turtle* could stay under only about half an hour.

Armament consisted of a piggyback time bomb made fast to an auger which the operator was to screw into the bottom of the enemy ship. When the time came for the *Turtle* to distinguish herself in combat, however, the auger could not pierce the *Eagle's* copper sheathing, and the *Turtle* had to cast her ticking torpedo adrift. A second contact was never made, and the *Turtle* was finally sunk by the British, while out of action and unmanned.

The *Turtle* set valuable patterns for future submarine development. Notable among them are the use of ballast tanks, conning tower, and screw propeller, and the proof that underwater attack could take an enemy by surprise. Writing 120 years later, John P. Holland called the *Turtle* "the most perfect thing of its kind constructed before 1880."

*The Nautilus.* In Paris at the turn of the century Robert Fulton had plans for a submersible warship—plans on which he set more value, according to some of his statements, than on his work on the steamboat. Interest in Fulton's plans was shown by Napoleon after he seized power in France in 1800. He advanced some funds, but Fulton worked mostly without encouragement. His vessel was the first submarine to be named *Nautilus.* In some respects, she seems to have owed not a little to Bushnell. Like the *Turtle,* she was screw-propelled under water, was submerged by admitting the sea to ballast tanks, had a conning tower, and was fitted with a sharp detachable spike attached to a torpedo (Fulton's word, from the electric ray, *torpedo electricus*) to be planted in the hull of a target ship.



SUBMARINE LIBRARY, GROTON, CONN.

*INTERIOR PROFILE OF DAVID BUSHNELL'S SUBMARINE, THE* TURTLE

Unlike the *Turtle,* the 21-ft. hull of the *Nautilus* approximated for the first time the fish-shape of modern submarines. The propeller, though turned by hand, pushed rather than pulled the vessel through the water. In still other ways the *Nautilus* was more like a submarine of the twentieth century than any of her predecessors: she was moved up and down by horizontal rudders, similar in principle and operation to the elevators of an airplane; the initial air supply was replenished from a small tank of compressed air; she was provided with a dual-propulsion system—the screw for submerged operation, a folding mast and sail for running on the surface.

When Napoleon lost interest, Fulton abandoned his boat and took his plans for both the submarine and the torpedo to England. There he demonstrated the latter by destroying the target brig *Dorothea.* The British did not want a sub-

marine, and he returned home to perfect his steamboat. Although he subsequently built the first steam warship, it is not clear that he ever reverted to the submarine project. At his death in 1815 he was building an 80-ft. boat to be propelled by a "silent engine" and named the *Mute*. This may have been a surface craft; however, a government report written half a century later says it was to run on the surface "habitually," but that "on approaching the enemy, it was to dive quickly under the water."

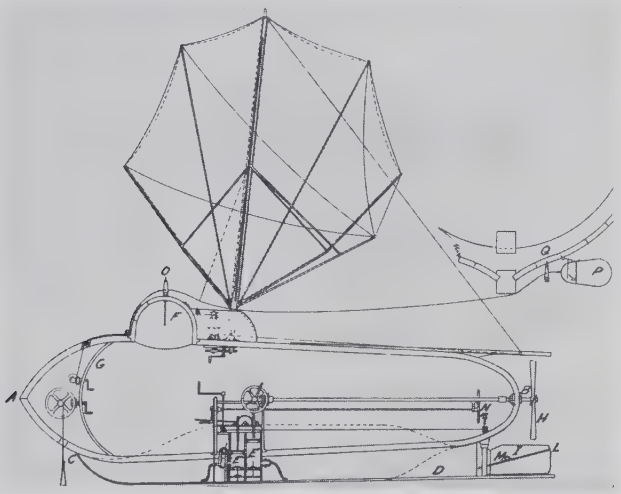



*Diagram of Fulton's* Nautilus *showing: AB, the ellipsoidal body; CD, metal keel; EE, pumps; F, metal conning tower; G, cross bulkhead; H, propeller; I and L, vertical and horizontal rudders, with fulcrum, M, and gears, N; O, horn; P, torpedo; Q, bottom of the vessel.*

*Last of the Muscle-Boats.* For more than half a century after Fulton abandoned the *Nautilus,* no significant contributions were made to submarine science. The one major problem Bushnell and Fulton had not solved (a strange omission in Fulton's case) was that of adequate power to turn the screw propeller, established as standard equipment after the *Nautilus* appeared. Their numerous and often talented successors did not begin to solve the problem until the last quarter of the nineteenth century. The 52-ft. *Diable Marin* which Wilhelm Bauer built to sell to Russia during the Crimean War, though formidable in many respects, could move only as fast as her crew's legs would work the treadmill which turned her propeller shaft. The 40-ft. submarine cigar with which in 1851 Lodner Phillips explored parts of Lake Michigan was also successful in many ways—apart from her limitation to one manpower and her apparent inability to withstand the pressure to which he exposed her on his last fatal dive in Lake Erie.

The American Civil War produced no important advance in submarine science. Its one true submersible, the Confederate vessel *Hunley,* was propelled by eight men laboring at a crankshaft. She was running on the surface when she drove her spar-torpedo against the U.S.S. *Housatonic,* sinking it and herself. This was the first sinking of a ship by a submarine. Even as late as 1872, the U.S. Navy seriously considered a clumsy, manpowered, iron blimp named *The Intelligent Whale* which was to anchor under water and send out a diver to torpedo things. At this date, ironically, Jules Verne had already published *20,000 Leagues Under the Sea;* its *Nautilus* not only embodied every improvement then envisioned by submarine science but possessed a mysterious, virtually unlimited source of power. By the light of contemporary technical progress, as exemplified by *The Intelligent Whale,* Verne was a visionary indeed!

**The First Powered Submarines.** *Compressed-Air Engines.* An attempt to improve submarine propulsion was made in great secrecy by the French Navy in 1863. *Le Plongeur,* a 146-ft. boat designed by Charles Brun, had an 80-hp. compressed-air engine. For some reason, she seems to have been little faster than craft which depended on human muscle power and was almost unmanageable under water. She is credited, however, with an innovation which is standard in twentieth-century practice—the use of compressed air to expel the water from the ballast tanks when surfacing.

*Steam Engines.* Two other sources of marine power were available to submarine designers: steam and electricity. Steam had obvious drawbacks for underwater craft, but in 1879 an English clergyman named Garrett set out to overcome them. When his *Resurgam* (meaning, "I shall rise again") was ready to dive, its smokestack was retracted, its fires sealed off, and the steam from its boilers used until exhausted. Two years later, the Swedish inventor Thorsten Nordenfeldt, now in partnership with Garrett, adopted this same system and so improved on it that the submarine *Nordenfeldt I* could run 14 mi. on her bottled steam. Nordenfeldt and Garrett also revived Bushnell's plan of submerging by the action of vertical propellers instead of diving planes. They were probably the first to adopt the self-propelled torpedo as the submarine's chief armament.

*Nordenfeldt I* was sold in 1886 to the Greek Navy; two others were purchased by Turkey. All had serious initial trouble keeping a horizontal position under water. Nordenfelt submarines later became popular and were the first type adopted by the German Navy.

*Electric Engines.* The French were the first to experiment intensively with an all-electric drive for submarines. This type of power had previously been installed in an English *Nautilus* which failed in 1884 to justify a new system of submergence devised by her builders, Campbell and Ash, and in a Spanish submarine brought out by Don Isaac Peral in 1887. The first French electric boat was the 59-ft. *Gymnote,* completed in 1888 according to plans originally drafted by Dupuy de Lôme and finished after his death by Gustave Zédé. She was equipped with a 55-hp. motor, a telescopic conning tower, and diving planes (horizontal rudders on the order of those used by Fulton 90 years before). The *Gymnote* was the first submarine commissioned in the French Navy. Although neither she nor her larger successor the *Gustave Zédé* were wholly successful, the French built other electric boats before 1901.

The trouble with these power sources—steam, compressed air, and electricity—was that they were exhausted so soon. This either imposed an absolute limit on cruising range, since an electric or air boat had to return to base frequently to charge her batteries or bottles, or compelled the boat, if a steamer, to surface, fire up, and so advertise her presence.

## THE MODERN SUBMARINE

**Holland and the First U.S. Naval Submarine.** Most submarines late in the nineteenth century suffered from a movable center of gravity. Motion under water was consequently erratic and often amounted to loss of control. The man who was to lead in solving these two problems was already at work in the United States. He was a New Jersey schoolteacher named John P. Holland who had been planning submarines since 1859, when he was a youth of seventeen in Ireland. Convinced that deficient power had caused

all previous submarine failures, he was considering a gunpowder engine when other designers were relying on human strength. Newly come to America in 1872, he resumed his experiments, settling himself several problems besides that of propulsion. He was interested in attaining proper ballast, buoyancy, and trim; in methods of storing energy and air; in obtaining clear vision; in strengthening the hull, and perfecting a self-propelled torpedo installation.

His first proposed boat, designed in 1875 but apparently never built, was to have been a 10-ft. capsule, 2 ft. in diameter. The operator reclined in it, breathing air from the fore and aft chambers through a respirator and turning the propeller by foot pedals. As in the case of Bushnell's craft, provision was made for an external torpedo which was to be attached to enemy hulls. *Holland No. 2* followed. In it the inventor conducted many trials on the Passaic River in New Jersey. It was a one-man craft with a double hull, between which were ballast tanks, and a four-hp. petroleum engine, one of the earliest and least successful internal-combustion power plants.

The first really competent Holland model was a 30-ft. three-man craft built in 1881 and nicknamed the *Fenian Ram* because it was financed by the Irish expatriate Fenian Society. Propelled by the 17-hp. double-acting oil engine just perfected by Brayton, she made 7 mph on the surface. She had vertical and horizontal rudders, could dive "with dexterous swiftness," and was armed with an "air gun or bow tube" from which dynamite could be discharged under water. Holland experimented intensively with her for two years, learning, among other things, that "guiding a boat by direct vision while submerged was impracticable."

Holland's designs won him a government contract in a public competition in 1893. The submarine he built on the contract was the triple-screw *Plunger*. It was to have been driven by steam on the surface and by electricity below, but was unsatisfactory. Holland therefore devoted time to further development work. In 1898, he launched the epoch-making *Holland*. After two years of experiments, modifications, demonstrations, and government tests, the *Holland* emerged as the first practical and reliable submarine in history. She was 53 ft. long with a maximum diameter of 10 ft. 3 in. and a displacement of 74 tons on the surface. She had two horizontal rudders and a three-bladed screw. A gasoline engine of 50 hp. enabled the *Holland* to do seven knots on the surface; electric motors drove her along at six knots when she was submerged. Thus, the dual-propulsion system characteristic of submarines built in the next 50 years was first successfully achieved by Holland.

The vessel had no periscope (Holland had included one in the plans for the unfinished *Plunger*), glass portholes being built into the low conning tower. Steering the vessel toward a target and aiming its forward torpedo tube was accomplished by "porpoising"—rising quickly to the surface for a sight and promptly submerging again. The boat was purchased by the U.S. government on April 11, 1900. Named the *U.S.S. Holland,* it was the first naval submarine.

The *Holland* and all typical Holland submarines had a single hull. Ballast tanks were placed low within the main pressure hull, instead of between it and an outer hull as in double-hull vessels, such as *Holland No. 2* and the French *Narval,* commissioned in the same year as the *Holland.* Holland made it a rule that the main ballast tanks must be full when the boat was in diving trim, thus stabilizing the center of gravity and eliminating the sloshing and resultant underwater see-sawing which had plagued early boats. The adjustments necessary to establish neutral buoyancy and trim he carried out by means of smaller tanks.

**Lake and His Submarines.** Holland's chief rival in perfecting the submarine was another American, Simon Lake. A boyhood reader of Jules Verne, Lake determined to make a submarine like Captain Nemo's *Nautilus,* as much at home on the bottom as anywhere else. Unlike most of his contemporaries, he did not think of the submarine as purely an instrument of war.

His first plan, which lost out to Holland's in the 1893 competition, was for a double-hulled, twin-screw craft with vertical propellers for submerging, a folding periscope, and retractable wheels for running on the bottom. An air lock allowed divers to leave and return to the boat. It was a compartment with one watertight door closing it off from the rest of the boat and another opening to the sea which was to be kept out by increased air pressure within the compartment. The plan also embodied a solution to the problem of longitudinal instability, which Holland was working on along other lines at the same time. Lake's idea was to keep the submarine on an even keel at all times, even when descending and ascending, by means of a multiple system of horizontal vanes and rudders placed at bow and stern. This enabled both ends of the vessel to be raised or depressed together. Larger side fins, somewhat like stubby airplane wings, maintained level forward motion.

Lake actually constructed his first boat on much simpler lines than these. The *Argonaut, Jr.* of 1894 was a triangular wooden box 14 ft. long by 5 ft. deep, with three solid wooden wheels on which she could be cranked along the bottom by hand. As a result of her success, Lake built in 1897 the 36-ft. *Argonaut* driven by a 30-hp. gasoline engine. Engine and occupants were supplied with air through a floating tube, which later was replaced by tall hollow masts. The typical Lake wheels and diving port were present.

*THE FIRST SUBMARINE OF THE U.S. NAVY, THE U.S.S. HOLLAND*

SUBMARINE LIBRARY, GROTON, CONN.

In 1898 Lake rebuilt the Argonaut, adding a schoonerish superstructure to her low cigar-shaped hull. This addition, vented to flood when submerged, added greatly to her seaworthiness on the surface. It also set a pattern for submarines of our century. Before the *Argonaut* appeared, boats usually had a completely watertight hull, entered through a hatch at the top of the watertight conning tower which rose from the pressure hull. After 1900, most submarines followed Lake's design and carried a "free-flooding superstructure." This is an enlarged bridge over the conning tower and decks. It runs most of the length of the hull and tapers at the bow to a conventional surface-craft cutwater. Such a superstructure is usable only in surface cruising. It is not watertight, but pierced with enough openings so that the sea fills it as the boat submerges and drains off automatically as it rises.

In summary, Lake's contributions to submarine technology included his system of submergence without slanting the keel, his air lock for divers, the free-flooding superstructure, and a primitive sort of snorkel tube.

**Nonmilitary Submarines.** Men have had many motives, latent and professed, for building submarines. Most wanted to produce a war machine; some—like Fulton and, in one of his moods, Holland—hoped to make war so terrible that it must be abolished. Of this latter persuasion was Professor Josiah Tuck, who opposed Holland, Lake, and Nordenfeldt in the 1893 contest. His *Peacemaker* was a 30-ft. steel submarine propelled by a "fireless steam engine" in which heat was generated by caustic soda. At first she carried a diver in an open cockpit on top. His job was to place electrical buoy-torpedoes under enemy ships.

Among the nonmilitary purposes suggested for submarines have been transportation, exploration, and salvage work. Submarines for the peacetime carriage of passengers and cargo have had many advocates; for years, it was argued that travel would be far swifter and more comfortable under water than on the surface. As early as 1650, De Son said his "Rotterdam Boat" would travel as fast as a bird and make a round trip between Rotterdam and London in a day. In 1889, the Russian submarine enthusiast Apostoloff was advocating a submarine craft threaded like a screw, to spin its way across the Atlantic in a little over 24 hours. Goubet, inventor of two practical French electric submarines, proposed in 1902 an undersea passenger liner to divest ocean-travel of all terrors.

Except for Drebbel's underwater excursion boat, such submarines have remained proposals only. The submarine, as it gradually evolved, continued to be slower under water than awash, more uncomfortable than the most uncomfortable surface ship, and far too small to carry a payload of freight. Only the exigencies of war have occasionally forced it to be a carrier. In 1916 the *Deutschland* maintained a brief and tenuous merchant service to and from America through the British blockade before being converted to a fighting craft. In World War II, naval submarines of several combatants carried high-priority passengers and cargo to points they had to reach by stealth, and it is known that since 1945 our navy has experimented with merchant-type conversions. Several large submarines have been made into troop transports, cargo carriers, and oilers.

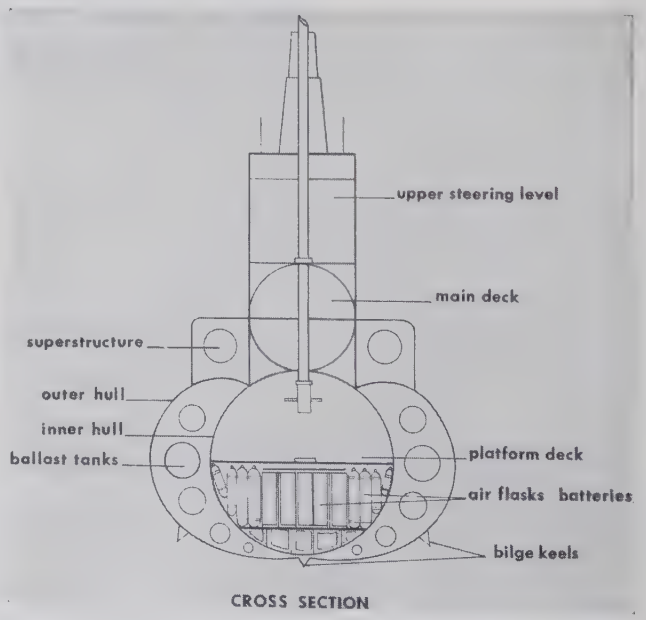
Some early inventors, including Phillips and Lake, numbered exploration among the possible uses of the boats they built. In 1931 Sir Hubert Wilkins used the former USS O-12, converted and renamed *Nautilus,* for his north polar expedition, penetrating within 450 mi. of the Pole in her. The outstanding nonmilitary function of the submarine to date has been in performing salvage and similar work under water. For a time in the last century, it appeared that this might rival the submarine's utility as a weapon. It is not entirely clear whether Barrié's seventeenth-century "packet" was a submarine or a diving bell. Dr. Payerne built his *bateau cloche* in 1846; it was a 35-ft. screw-propelled semi-projectile which divers could leave and enter under water. It is said to have worked successfully on the Cherbourg breakwater.

In 1851 Phillips reported that he had sawed 14-in.-square timbers under water from inside his Lake Michigan submarine. Simon Lake demonstrated the feasibility of salvaging material from sunken wrecks. He accurately perceived that an effective salvage submarine must be able to carry divers to their working area, let them out on the bottom, and take them back when the job was done.

At the turn of the twentieth century, several European inventors devised submarine working boats. The Italians, Piatti del Pozzo and Cavaliere Pino, produced spherical or ovoid craft. Although they were equipped with screw propellers, they were designed to work suspended from surface vessels, the ovoid vessel at depths exceeding 300 ft. Degli Abbati built *L'Audace,* a 28-ft. flattened projectile carrying four men. It was lighted and driven by electricity. The Abbe Raoul of Tunis Cathedral is also credited with a successful 16-ft. lemon-shaped boat.

These "peaceful submarines" had a common defect: experience showed that their functions could be more efficiently and less hazardously performed by divers, diving chambers, or surface craft. Hence, they have had few successors. The submarine has become ever more exclusively a weapon—more terrible each year.

**Submarine Developments in the Twentieth Century.** By the start of this century, only a few standard items of equipment had yet to be added to or to become universal on the submarine. The periscope, known to submarine science since at 1854 at least, had been incorporated in both Holland's and Lake's 1893 plans. Perfected in Europe, it was installed on a U.S. submarine of the predominant Holland type in 1902. Development of the gyrocompass gave the submarine its bearings under water; magnetic com-

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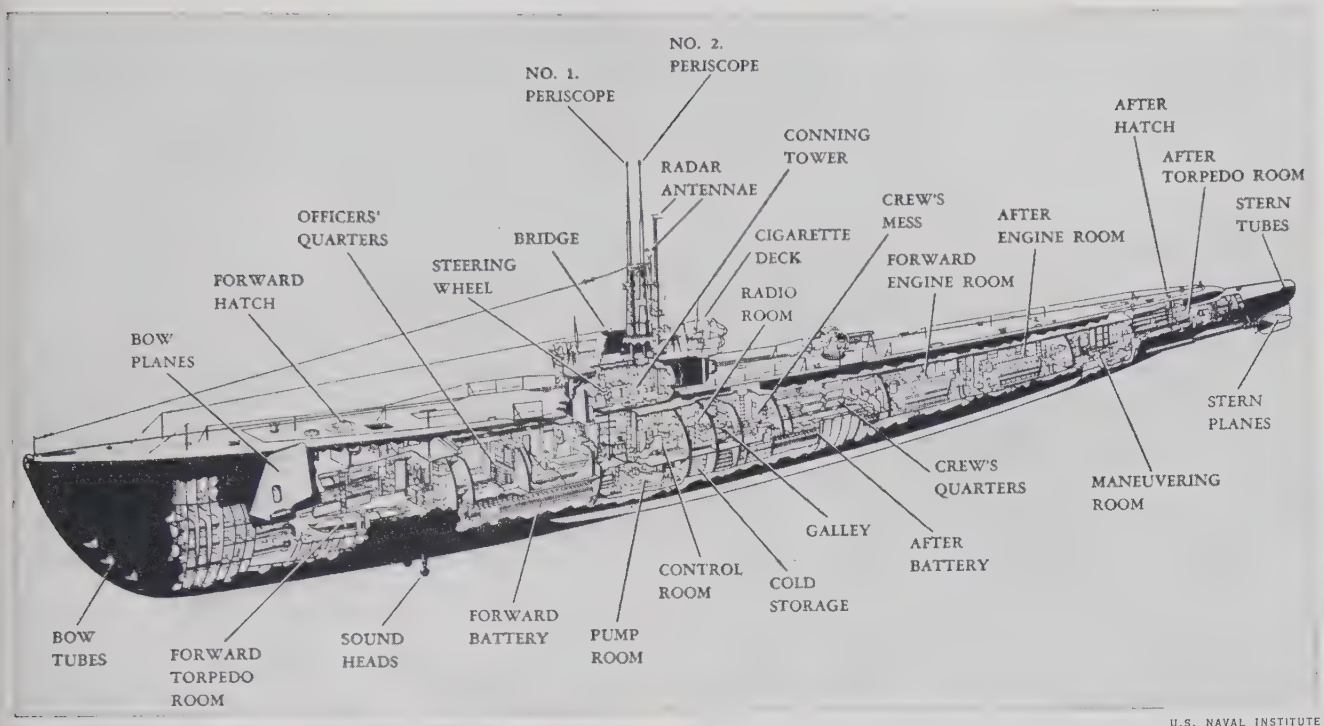
*CROSS SECTION OF CONVENTIONAL SUBMARINE*

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*CUT-AWAY DIAGRAM SHOWING COMPARTMENTATION OF CONVENTIONAL U.S. SUBMARINE*

passes had been almost useless when crowded by so much steel and electricity.

Fully practical propulsion came when the diesel engine replaced the tricky and dangerous gasoline power plant for surface drive. Adopted by the Germans in 1906 and by the British soon after, it came to be universally used either directly or in diesel-electric installations. Steam was employed, however, in the large, fast British K Class of World War I. More recently, atomic and other advanced power sources have been developed for submarines.

The single-screw propulsion of the Holland prototype was replaced by the twin screw, and single-hull construction by double-hull with main ballast tanks on the sides outside the pressure hull. Underwater communication was greatly advanced by the adoption of the oscillator. This device is based on the theory which enabled development of the telephone. It permits detection of nearby vessels and the receipt of messages under water, where radio is useless.

Since 1900 the submarine has evolved exclusively as an instrument of war. Its basic weapon has been the self-propelled torpedo, generally driven by compressed air or, more recently, by electricity which leaves no telltale wake. Deck guns and machine and anti-aircraft guns have also been carried; the trend at present is toward removal of these surface-type weapons.

There were no revolutionary changes in the structure, propulsion, and equipment of submarines from the start of World War I to the closing months of World War II. Among major problems to be solved were increasing operating range and speed, especially under water; decreasing diving time, and prolongation of submergence. These problems were studied between wars, as were those of specialization and rescue. By World War II, the United States submarine fleet ranged from small coastal types of 200-400 tons surface displacement to the giant *Argonaut* (minelayer), *Narwhal,* and *Nautilus,* which were of more than 2,700 tons. Surface speeds provided by diesel engines were 14-21 knots; submerged speeds, from electric propulsion, 8-11.

*Rescue Devices.* Ever since man first submerged in a submarine, its sinking has been a virtual death-warrant for her crew. In the 1920's, every man died who went to the bottom with the American submarines S-51 and S-4, and, as a result, the U.S. Navy put heavy stress on developing rescue devices. Two were ultimately adopted as standard equipment. For wrecks at shallow and medium depths, all American submarines are equipped with the Momsen Lung, an individual oxygen-breathing device which men could wear while leaving the sunken submarine's escape-hatch and ascending a lifeline to a surface buoy. For rescue at greater depth, the McCann Rescue Chamber was adopted.

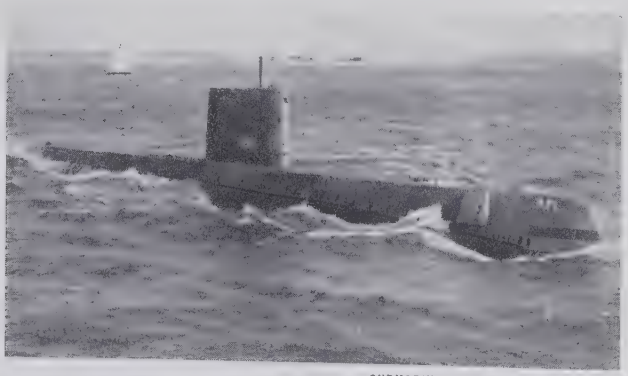
Although World War II was fought with conventional submarines, it was the incubator for radical new developments, many of which had scarcely begun to take form by V-J Day. The two most successful submarine fleets, the German and the American, were strikingly different in many respects. The American was built around the fleet-type submarine, a relatively large boat developed between wars. It was capable of patrols of two or three months during which, in the absence of effective enemy countermeasures, much time was spent on the surface.

*The Snorkel.* The German boat, on the average, was smaller. It was a stripped-down fighting machine with a minimum of crew comforts, designed for shorter forays, and compelled by concentrated and ever-deadlier opposition to spend as much time as possible under water. This need of maximum concealment led to the development of the snorkel, which could be raised to periscope height for taking in and exhausting air while the submarine was running underwater. The snorkel's primary object was to furnish the large and steady flow of air needed to permit underwater operation of the diesel engines and also to dispose of their exhaust. It thus removed an increasingly hazardous limitation under which combat submarines had labored since diesels were adopted: the need of surfacing to recharge the batteries. This required operation of the diesels which, heretofore, had been useless under water. Another purpose of

the snorkel was to augment the air supplied to the crew for breathing.

*The Midget Submarine.* Another distinctive development of the period was the midget submarine which all major navies used in one or more forms. The simplest type was the British "chariot," a submersible propulsion unit little more than a torpedo with a detachable warhead. Two frogmen rode astride the chariot. One operated the controls; the other cut submarine nets; together, they attached the explosive warhead by clips to the keel of the target. Slightly larger midgets, carrying crews of two or four men, were submarines in miniature. They were designed to slip into harbors or shallow waters on special missions, as in the Japanese attack on Pearl Harbor. Midgets, of course, operated at short range and had to be transported within striking distance by surface ships or mother submarines.

By 1943, the Allies had developed such effective counter-submarine measures that it was unsafe for German U-boats to surface at all. Even snorkel or periscope could be picked up on radar. Hence, late in the war, the Germans concentrated on developing radically new submarines which could be submerged longer and deeper, and which had increased underwater speed and quieter mechanical operation. "Type XXI" was to be a streamlined U-boat with enormously increased battery power to reverse the normal ratio of submerged to surface speed and with great pressure resistance for greater depth. "Type XXVI" was to be more streamlined, even to the elimination of deck guns and most of the conning tower and equipped with four alternative propulsion units. The chief of these, the Walther cycle turbine, was to drive her at an underwater speed of 25 knots and to permit continuous submerged operation. This turbine derived its energy from combustion of diesel fuel in decomposed hydrogen peroxide. Neither type submarine had been placed in service by the end of the war, but they are evidence that German submarine research was directed toward the problem no submarine scientist had yet solved—how to make a submersible truly a submarine; how to achieve a vessel with unlimited capacity to remain and maneuver under water. Whether the Germans would have achieved that end is still largely a military secret of the countries which conquered Germany at a time when these submarines were about ready for a practical trial. It is reported that the Germans' unfinished task was carried on by the Allies and that Great Britain has installed a version of the Walther turbine in two submarines, the *Excalibur* and *Explorer.*



SUBMARINE LIBRARY, GROTON, CONN.

*THE FIRST ATOMIC POWERED SUBMARINE, THE U.S.S.* NAUTILUS

*Atomic Submarines.* The utilization of atomic energy became a reality with the launching, trials, and acceptance by the U.S. Navy of the *Nautilus,* the latest of the real and fanciful submarines to bear that favorite name. The *Nautilus* is an improvement on previous submarines in almost all respects. She is revolutionary in one. That one, of course, is her engine. More specifically, it is the heat source or power plant, the engine itself being simply a high-speed turbine driving the propeller shafts through reduction gears. The *Nautilus,* like Holland's *Plunger* and the Nordenfeldt-Garrett boats, is a steam vessel.

The steam submarine of earlier decades was defeated by the absence, under water, of an adequate air supply for combustion and of a feasible vent for exhaust gases. The combustion chamber of the Nautilus requires neither air nor exhaust. It is an atomic pile, heavily shielded to protect the occupants of the vessel. The tremendous heat generated by the fission of uranium atoms in the reactor is communicated to specially and continuously purified water pumped through it under such extreme pressure in a sealed system of pipes that the water will not turn to steam. This heated water passes into a heat-exchanger, where it turns the water of a separate sealed system into high-pressure steam. The last rotates the turbine, as it does in any modern marine steam propulsion unit.

The atomic power plant and its capacities tinge and modify everything else about the *Nautilus.* Her hull is typical of submarines as to components, but it lacks the sharp cutwater of previous boats. The *Nautilus* is fully streamlined for underwater cruising; deck projections are eliminated. She is designed to withstand enormous pressures—all that has been revealed officially is that she will outdive any predecessor. The *Nautilus* also realizes one of the earliest dreams of submarine theorists. She runs faster submerged than surfaced, having an underwater speed of more than 20 knots. Highly specialized electronic equipment enables her to find her way beneath the surface, to perceive and distinguish friendly and unfriendly vessels, and even to join combat with enemy submarines under water. For protracted submerged patrols, she is also much more comfortably arranged and equipped than any forerunner. She is large—about 3,000 tons displacement—and her economies, especially in the matter of fuel tanks, allow the crew much more generous air-conditioned living space than was possible on earlier boats.

The *Seawolf,* a companion to the *Nautilus,* is understood to differ from the *Nautilus* chiefly in that the coolant fluid which transmits the heat of fission to her heat-exchanger is liquid sodium instead of water. With these two craft, the submarine has caught up to the imagination of Jules Verne.

*See also* SHIPS, NAVAL.

C. B. M.

**SUBMARINE RESCUE CHAMBER,** a contrivance for rescuing personnel from a submerged submarine. It is a steel structure, 10 ft. high and weighing about nine tons. Its maximum external diameter is 7¾ ft. and it tapers downward to a base diameter of 5 ft. It is open at the bottom, and around the bottom edge is a rubber gasket which serves to make a watertight seal between the chamber and a machined apron that surrounds each escape hatch at the deck level of the submarine. Every submarine in service has two of these hatches, one at each end of the ship.

The chamber is capable of withstanding an exterior pressure equivalent to the submergence crushing depth of any U.S. Navy submarine. Internally, the rescue chamber is subdivided into a large upper compartment, in which all control apparatus is housed, and a lower, smaller compartment which is surrounded by a single ballast tank. Between the upper and lower compartments is a hatch which can

only be opened from the inside. The capacity of the ballast tank and of the lower compartment is the same, either taking 4,000 lb. of salt water to fill it.

Outside on the top of the chamber are four watertight fittings. One serves as a connection for the 1-in. wire-wound hose that delivers compressed air from the tending vessel, and another is a connection for the 1¼-in. wire-wound hose that carries back to the surface craft all air vented from within the rescue chamber and the exhaust of the chamber's air motor. The third fitting is a connection for the telephone circuit, and the fourth connects the cable that carries current for the electric lights in the two compartments. By turning on the light in the lower compartment, an operator in the upper one can peer through an eyeport in the floor and see if all is clear. In addition to these four fittings, there is a large external pad eye for hoisting the chamber in and out of the water; when the chamber is being operated a ¾-in. wire is made fast to it and is called the backhaul wire.

**Upper Compartment.** The upper compartment holds the operators and passengers. In this compartment are: the operating motor with its air supply, exhaust lines, etc.; the blow and vent manifold for the lower compartment, and ballast tank. The water manifold for flooding and emptying the lower compartment and ballast tank, a hose connection for filling the 14 movable adjusting tanks, plus gauges, lighting system, telephone, four holding-down bolts, etc., are also therein. Three eyeports are fitted into the sides of the hull of this compartment, and, in addition, there is one eyeport in the floor to see into the lower compartment.

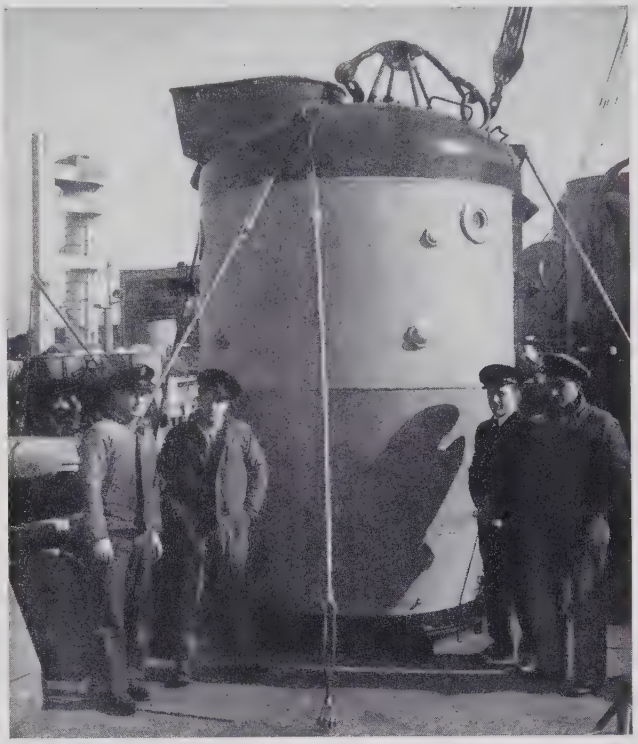
**Lower Compartment.** The lower compartment contains the downhaul cable and reel, a sheeve through which the wire runs, and a bracket which serves as a fair lead for the wire that centers it in the compartment when hauling in or paying out. This cable is of 7/16-in. plow steel wire. One end is secured to the reel, and to the other end a special shackle is made fast to fit the bail of a submarine hatch. The sheeve and bracket can both be swung back out of the way after the cable has been unfastened from the submarine hatch to allow this hatch to open and to provide necessary room for the passengers to enter the chamber.

In a circular web running around the inside of the hull in this compartment are a number of slots spaced at equal intervals. The threaded ends of the holding-down rods, stored in the upper compartment, fit into these slots; the other end hooks into the pad eyes around the outside of the submarine hatch to hold the chamber on the submarine.

**Ballast Tank.** The ballast tank is a closed annular compartment in the hull of the rescue chamber which runs completely around the lower compartment. Access to this tank is through handholes from the lower compartment. In the bottom of this tank is the permanent lead ballast which is used initially to compensate the chamber when it is put in service, and the weights are so positioned that the chamber floats level in the water instead of listing toward the side that the motor and reel are on. This lead ballast is kept from shifting by the internal vertical ribs inside of the ballast tank, so that if the chamber should be placed on its side these weights would not fall down to the low side.

## OPERATION

Before the chamber can be used for rescue, it must be assumed that the sunken submarine has been located and that a submarine rescue vessel or a similar craft is moored over the wreck. Enough wire must then be run off the reel of the chamber on to the deck of the surface vessel to reach the bottomed submarine, with some slack left over. A diver then takes the end of this wire down with him and connects it to the bail of the submarine hatch, inspects the hatch to ensure it is clear of debris, and returns to the surface. As soon as the diver is clear, the rescue chamber, with its five attachments (supply hose, vent hose, telephone cable, light cable, and ¾-in. backhaul wire), is lowered over the side with two operators, usually divers, where it floats alongside of the tending vessel. The operators then fill the fourteen movable adjustable tanks, which hold 67 lb. of water each, giving the chamber a weight load of nine persons. The



U.S. NAVY PHOTO

*SUBMARINE RESCUE CHAMBER ON DECK OF RESCUE VESSEL*

chamber with nine persons in it has a positive buoyancy of approximately 1,000 lb.; these tanks are filled to make the chamber heavier and relieve the motor of extra work on the descent. All entrapped air is then vented from the top of the lower compartment allowing this space to become full of water. The chamber is now ready for its descent.

When the operators start the air motor, the cable winds on the reel, and the chamber is pulled down toward the submarine against its own positive buoyancy. During this descent, the air motor is exhausting into the vent host and the chamber operators are riding in a space that is under atmospheric pressure, no matter how deep the chamber goes—unless special work requires the chamber to be operated virtually as a diving bell.

The chamber usually descends at a rate of about 20 ft. per min., and the operators, by reading a gauge in the side of the chamber, can determine their depth as they would in a submarine which is operating submerged. The motor is so designed that it will stall before it can put a breaking strain on any part of the apparatus. When the bottom of the chamber strikes the submarine hatch seat, or, if the visibility is such that the hatch can be seen through the eyeport, when the hatch comes into sight, the motor is slowed down and is allowed to draw the chamber down as tightly as possible against the seat. When the submarine is listed to one side on

the bottom, it may require some maneuvering to get the chamber against the seat and especially to get it reasonably well centered over the hatch; however, it is not impossible at any angle at which the submarine is likely to lie.

With the chamber on the seat, the ballast tank is now flooded. While this tank is being flooded, a heavy strain is maintained on the downhaul cable to take in any slack that might result from this operation. As this compartment is flooded, the chamber goes from a positive to a negative buoyancy. As soon as this tank is full of water, the lower compartment is blown dry of water by blowing it out either under the gasket or through the water manifold. The chamber operators can tell when this compartment is dry because the chamber shudders as the air rumbles out from under the gasket, and they can also see the air bubbles rise past the ports on their way surfaceward. The air is now shut off and the vent to the lower compartment is opened wide, allowing the air pressure to come into the upper compartment and out through the vent hose to the surface.

As the lower compartment vents, the sea pressure seals the chamber tight against the seat. During the venting, the operators determine if a seal is made by looking through the eyeport into the lower compartment. If a seal is made, the lower compartment fills with vapor. If the compartment fills with water instead of vapor, the attempt has been unsuccessful, and it will be necessary to blow the lower compartment and try again. When a seal has been made, the lower hatch is opened. One man drops into the lower compartment and fastens the four holding bolts tying the chamber to the submarine. When they are secured, the cable is slacked off and the guide bracket is swung to one side. The submarine hatch is now opened and personnel enter the chamber. A total of six to seven average-sized men may be taken aboard the chamber, without reducing the reserve buoyancy below 1,000 lb., by emptying all the adjustable ballast tanks that are stored in the upper compartment.

When no more than seven passengers are in the chamber, the submarine hatch is closed. The fairlead bracket is swung back to the center, re-rigged, and a strain is again placed on the downhaul cable. The four holding-down bolts are removed and passed up into the upper compartment. The adjustable ballast tanks are dumped into the lower compartment on to the submarine hatch. The lower chamber hatch is closed and the lower compartment is flooded from the sea. The ballast tank is now blown and the buoyancy breaks the seal. The motor is now operated to pay out the cable on the reel and the chamber floats surfaceward. On reaching the surface, the chamber is floated over to the side of the tending vessel where the passengers disembark and the chamber is ready to commence another trip.

In order to carry more than seven passengers, no tanks are dumped, and the chamber rises to the surface with the lower compartment empty; as many passengers as the upper compartment will hold, in addition to the crew, may then be carried. In October 1947, a rescue chamber from the submarine rescue vessel *U.S.S. Tringa* removed 16 passengers from the submarine *Corsair;* with the two operators, 18 persons were in the chamber during a test exercise.

Once a trip has been made, the chamber can make another very quickly, and it is easier to control the chamber with its normal reserve buoyancy of 1,000 lb. than with the much larger buoyancy which will result from the lower compartment being empty even with the upper compartment full of passengers.

During September 1948, final tests were completed on a downhaul, wire-messenger buoy. With this device, it is no longer necessary for a diver to connect the downhaul wire before the chamber can be used. Two of these buoys are fitted into the deck of each submarine, one on the bow and one in the stern, with one end of the downhaul wire made fast to the submarine hatch bail and the other to the buoy.

When released by the submarine, the reel pays out wire until the buoy surfaces. Then it locks so that no extra cable is allowed to pay out and become fouled on some portion of the submarine. Upon the arrival of the rescue vessel, the wire is transferred from the buoy to the rescue chamber. Rescue is possible at depths greater than a diver may be able to go. P. C. C.

**SUBORDINATION,** in sentence structure, the employment of subordinate clauses with independent clauses to indicate the relation of the ideas expressed in these clauses. It is contrasted with co-ordination, in which all clauses are independent and all the ideas expressed in them are accordingly presented, at least formally, as of equal importance.

By co-ordination it is always possible to express a meaning that is usually conveyed by the use of subordinate clauses. Examples of such co-ordination are frequent in Latin, especially in early writings; a characteristic one is Plautus' *filiolam ego unam habui, eam unam perdidi* ("I had one little daughter, I have lost that one"). Constructions of this kind are more frequent in English than in other modern languages, familiar examples being *obey my voice, and go fetch me them* (Genesis xxvii:13); *you should try and be reasonable; hurry up, it is getting late;* and *let him talk, it will do no harm.*

Co-ordination corresponds to a more primitive, simple, and direct approach to expression, whereas subordination reflects a greater logical capacity, a tendency to organize concepts hierarchically, to deduce consequences from causes, to connect different thoughts and facts into a complex architectural whole. Subordination expresses ideas with more precision and clarity than co-ordination and is the mark of a more rational and philosophical culture. Plato, Demosthenes, and Isocrates employed subordination much more than Homer; Cicero and Tacitus employed it much more than Plautus. With the decay of Latin culture, co-ordination again took the upper hand, and it predominated in the early documents of the Romance peoples until the culture of the Italian Renaissance again brought subordination to the fore. As is natural, co-ordination is preferred in the simple, colloquial speech of every day and in the literature that approaches it, in all times and among all peoples. Even Cicero employed co-ordination in his rather simple and colloquial philosophical writings, and still more in his letters, whereas in his carefully prepared and highly artificial orations subordination reaches its peak. Writers of satire and epigram, the literary genres that are nearest to the spoken language, definitely prefer co-ordination, as do rather colloquial poets like Propertius and Ovid. The early Christian writers, in their enormous and successful effort to reach the masses, virtually abandoned Classical subordination, especially in their sermons and their vivacious polemical writings. Popular authors like Chiron used co-ordination amply, and so, merely as an imitation of Old Latin, did the archaists.

While subordination gives a calm, thoughtful, and somewhat pale and sedate tone to language, co-ordination is more colorful, forceful, and dramatic. It is not surprising, therefore, that English, a rather simple, energetic, and direct language, manifests a strong tendency toward co-ordination. Modern languages in general, however, with the possible exception of German, show more co-ordination than Latin

and Greek, perhaps because many Classical authors had an artificial refinement that is seldom found in modern times.

Another reason why the written language uses more subordination than the spoken one is that co-ordination depends largely on gesture and on the pauses and intonations of the speaker's voice; these elements do not appear in writing, where consequently other characteristics distinguishing subordinate from co-ordinate clauses become necessary. Most important of these are the subordinative conjunctions.

While Proto-Indo-European had no subordinate clauses, it is certain that some, though not many, were in use in Indo-European in the last stage before the separation, and that they were clearly distinguished from the independent clauses. *See also* CLAUSE; CONJUNCTION. G. B.

**SUBOTICA** or **SUBOTITSA** [su′botitsɑ], a large agricultural, manufacturing, and trading town in Voivodina, Yugoslavia, about 100 mi. northwest of Belgrade and less than 10 mi. from the Hungarian border. A royal free city in Hungary, it was incorporated into Yugoslavia in 1918. Manufactures include mainly textiles, shoes, iron furniture, and railway equipment. Pop., 1948, 112,551. S. Van V.

**SUBSTANCE,** literally, that which stands under or supports the qualities and relations we directly observe.

"Substance" is a philosophical concept developed from certain common-sense convictions about the world, of which the three following have played important roles historically in determining the concept. (1) Sets of qualities and relations that cling together in perceptual experience have some matrix binding them together. Thus an apple is thought to be more than redness, sweetness, and sphericity: it includes a stuff or material uniting these properties into a single thing. (2) Observable changes are never complete changes. There is always something that persists, that is subject to change only in its properties, never in its inner being. Thus change is not a series of discrete and unconnected states, but a history of some persisting thing. Furthermore, this persisting something is continuous in existence between any two times in which it exists: it contains no gaps in its history. It is a single apple that ripens from green to red, not a series of apples. (3) Concrete existing things are more than sets of universals. The redness of the apple is not redness in the abstract; it is a concrete case of redness. The apple is not its properties; it has or exemplifies them. It is an existing individual characterized by properties, which are (or could be) also exemplified by other individual things.

These convictions of common sense, innocent as they seem, have given rise to serious problems in the philosophy of substance. One source of these problems is the confusion of the three convictions with one another. Though analogous, they are not identical, and when one concept is made to cover all, clarity is not achieved. Besides this, in each of these convictions, common sense goes beyond what is directly observed. Hence, in criticizing the common notions of substance, philosophers have often denied one or more of them.

Aristotle, the great philosopher of common sense, attempted to include all three convictions in his notion of substance. According to him, primary matter is a matrix binding "forms" (properties) together; it remains unchanged whatever forms are added or withdrawn; and it is the principle of individuation.

Plato had held a view of substance that was far more radical from the standpoint of common sense. Since he held that forms (qualities and relations) are substantial in their own right, he denied the third conviction of common sense listed above, arguing that individuals cannot really be known, but only universals. It may be questioned whether he did not deny the first conviction, for he thought that the unities of perceptual things are illusory. However, persistence despite the appearance of change was retained by Plato, although placed in universals (forms) rather than individuals.

The positivists—such as David Hume, J. S. Mill, Ernst Mach—have accepted the third of these convictions without the others. Their rejection of the first two has been on the ground that a unifying matrix and a persisting substratum are unobservable. Thus the individuals they accept are not unified and persisting physical things, but transient sense occurrences.

Alfred North Whitehead has developed a philosophy of events that retains the first common-sense conviction, but essentially denies the second and perhaps the third. The matrix uniting properties into an event is simply a temporal togetherness, an arising into the same unity of time.

In each of these cases there has been a tendency to push substance out of experience or to deny that it can be clearly known. But each philosophy has retained at least one of the basic common-sense convictions and it is worth noting that in each of these convictions common sense goes beyond what is directly perceived. Even extreme empiricists make of ongoing experience or perceiving a principle of individuation which cannot itself be perceived. The notion of substance is more than an empirical idea. E. W. H.

**SUBSTRATUM, SUPERSTRATUM, ADSTRATUM** [sʌbstre′təm, supərstre′təm, ædstre′təm], terms used in linguistic science to characterize languages which exert or have exerted some formative influence on other languages. Where the terms *substratum* and *superstratum* apply, the occasion for such influence is the invasion of one language's territory by speakers of another language; where the term *adstratum* applies, the languages concerned occupy territories that have a common frontier. When a linguistic territory is invaded, either by conquest or penetration, the superposed language of the invaders may or may not become predominant over the language of the territory. If the new language becomes predominant, the old language is known as the *substratum* of the new. If the old language persists and the superposed language is not adopted, the superposed language is known as the *superstratum* of the old language.

The three concepts were developed chiefly through the work of M. Bartoli, W. von Wartburg, and R. Jakobson in the twentieth century, but the idea of the substratum was first advanced as early as 1846, by G. I. Ascoli. By attributing to the conquered Celtic population of transalpine and cisalpine Gaul the change of Latin *ū* to *ü* in French, Provençal, Piedmontese, Lombard, and other languages, Ascoli showed that Celtic bore toward Latin what would now be called the relation of substratum. Latin has a number of other substrata, including Etruscan, Osco-Umbrian, Messapic, and Venetic, and it may be shown, among countless other examples, that English has a Celtic substratum, Russian a Finnish substratum, and Spanish an Iberian or Basque substratum, or perhaps both of these substrata.

Examples of superstrata are also abundant. Thus, in France the superstratum is Frankish; in Italy it is first Gothic, then Lombard, then Frankish; in Spain it is Visigothic and then Arabic; in Russia it is Scandinavian and then Tatar; in Greece it is Turkish and Venetian.

The adstratum is well exemplified in Germany. Although the Germans were never conquered in their great bulk by the Romans, their language was deeply affected by contact

with the Gallo-Romans in the Rhine valley. Through this contact, without any general transfer of population, the Germans received many cultural words (e.g., *Kirsche, Wein, Keller, Kalk, Essig, Kaiser,* etc.) and important grammatical and stylistic innovations of many kinds (e.g., Fr. *le chien* = Ger. *der Hund, un chien* = *ein Hund, j'ai vu* = *ich habe gesehen, il est allé* = *er ist gegangen, il a été tué* = *er ist getötet worden, je verrai* = *ich werde sehen,* etc.).

The respective importance of the three elements that these terms denote varies everywhere according to historical conditions. Thus, the importance of the Celtic substratum seems to be small in England, whereas it is rather strong in France; the part played by the Visigothic superstratum is almost insignificant in Spain, whereas the Arabic superstratum in Spain and the Frankish superstratum in northern France had an essential role in shaping the new languages. On the other hand, if the Norman-French superstratum had been a little stronger, or had received a few more reinforcements from France, English would now be a Romance language and Anglo-Saxon would be reduced, like Celtic in France, to the position of substratum.

It is sometimes difficult to distinguish between substratum, adstratum, and superstratum. For example, there is hardly any doubt that Basque has influenced Spanish, but it is not certain whether Basque is in this instance an adstratum or a substratum; similarly, Bulgarian has been influenced by Greek, and Romanian by Slavic, but it is uncertain whether these are examples of adstratum or superstratum. The problem, in any case, concerns history rather than linguistics, the distinction between substratum, superstratum, and substratum being an empirical one. The three terms offer a convenient device to indicate certain series of linguistic phenomena, but they do not cover all the manifold interferences and reciprocal influences that affect languages, for these are as changing and as complicated as life itself. G. B.

**SUBWAYS, ELECTRIC,** rapid-transit railways for passenger service located beneath the surface, usually under city streets. They may be as close to the surface as construction conditions will permit, or may be as much deeper as is considered desirable.

Subways have been in use for many years. Construction on the earliest line, part of the London Underground, began in 1853. The system was originally operated by steam; conversion to electricity was accomplished in 1891. Other lines were added to the system from time to time. In the United States, the first subway was opened in Boston in 1898 and the second in New York in 1904. Both systems have been extended several times. Elevated railways, an older form of rapid transit, fell into disrepute on account of the noise and the obstruction to light and air along the routes, so that in New York and Boston a portion of them were abandoned and replaced with subways. From an operating standpoint there is little difference, and some of the routes include both, subways serving the more congested sections.

Subways and elevated railways have private right of way, with no interference from street traffic. Passenger stops are usually much less frequent than on surface lines, being spaced from ¼ to ½ mi. apart for local trains and 1 to 3 mi. for expresses. In nearly all instances, stations are of the prepayment type in which the passenger pays before entering the loading platform enclosure. These arrangements permit higher operating speeds, larger cars, and trains made up of many cars. With these advantages, rapid-transit lines are able to move far more passengers at scheduled speeds up to double those of surface lines, and at low unit operating cost.

The disadvantage of subways and of rapid-transit lines, in general, is almost entirely the high cost of construction, which may be as much as $1,000,000 per mile of track. The expense usually must be borne by the municipality, as the carrying charges on the investment are so much higher than those for surface transportation that it is seldom possible for a private operator to assume the burden. Only four cities in the United States—New York, Boston, Philadelphia, and Chicago—have subway lines of any extent, and in each of these the public authorities have done all, or most, of the financing.

**Control and Power.** American rapid-transit systems and most foreign systems are operated by 600-volt direct current with trains of two to ten cars, all, or a part, of which are equipped with motors. Power is controlled from the motorman's position in a cab at the front end of the leading car by the multiple-unit control system, small currents in the master circuit actuating the main motor controllers on the various cars so that each does its own share in driving the train. Air brakes, likewise, are controlled from the motorman's valve by electric or pneumatic means, or by a combination of the two.

Power is almost always supplied from a.-c. lines, often those of the local utility. It is converted to direct current at the proper voltage in substations by synchronous converters or mercury-arc rectifiers, the latter being favored in later installations on account of their high efficiency and ease of automatic operation. The substations are spaced according to the power demand in order to maintain voltage as nearly uniform as possible throughout the system.

Since subways are on a private right of way, it is not necessary to keep the contact line out of possible reach. Only employees are allowed to approach the tracks, and they are trained to avoid live electric circuits. Accordingly, all American subways and most foreign ones are equipped with the third-rail system, in which a steel rail, supported on insulators alongside the track, supplies the current. Although the electrical resistance of steel is about seven times as much as that of copper, it is much cheaper and, with the method of support, the cross section can be as large as desirable. The contact surface is rigid and maintenance costs are low. Where the largest rail has insufficient conductivity to carry the current, it is supplemented with copper feeders. Contact with the third rail is made by shoes mounted on the trucks of the motor cars. Thus, there are many contacts in parallel, making it easier to collect the large currents required when starting, which in some instances run as high as 10,000 amp. per train. The multiplicity of contacts also gives continuity of power where the third rail is discontinuous, as at crossings or junctions.

RAPID-TRANSIT SYSTEMS OF THE WORLD

| *City* | *Route Miles* | *City* | *Route Miles* |
|---|---|---|---|
| Barcelona, Spain | 37.0 | London, England | 220.0 |
| Berlin, Germany | 47.0 | Madrid, Spain | 12.0 |
| Boston, U.S.A. | 22.0 | Moscow, U.S.S.R. | 16.0 |
| Buenos Aires, Argentina | 22.5 | New York, U.S.A. | 241.5 |
| Chicago, U.S.A. | 81.0 | Paris, France | 78.0 |
| Cleveland, U.S.A. | 12.0 | Philadelphia, U.S.A. | 23.2 |
| Elberfeld, Germany | 10.0 | Prague, Czechoslovakia | 15.0 |
| Glasgow, Scotland | 7.0 | Sydney, Australia | 2.5 |
| Hamburg, Germany | 25.0 | Tokyo, Japan | 8.0 |
| Liverpool, England | 6.5 | Vienna, Austria | 16.5 |

*See also* SIGNALING, RAILWAY. M. Bu.

**SÜCHOW.** *See* Tungshan.

**SUCKER,** a name given to any of numerous fresh-water fishes of the family Catostomidae, closely related to the carp. They have a suckerlike mouth with soft, thick lips. All species are found in North America except two which are native to Asia. Suckers are found near the bottom of streams and lakes feeding on aquatic plants and animals. Their flesh is poor but extensively eaten. The white sucker, *Catostomus commersoni,* native to streams east of the Rockies, attains a

COURTESY OF THE U. S. FISH AND WILDLIFE SERVICE

COMMON SUCKER, CATOSTOMUS COMMERSONI

length of 18 in. Buffalo fishes, the black horse, and the red horse are among the most important species belonging to this family. *See also* Buffalo Fish; Red Horse. C. R. Eb.

**SUCKLING, SIR JOHN** (1609-1642), English poet, was born in Twickenham, near London, and baptized Feb. 10, 1609. After attending Trinity College, Cambridge, he entered Gray's Inn. Inheriting a large fortune from his father, he traveled extensively in Italy and France; on his return to England in 1630, he was knighted. With the Marquis of Hamilton he fought under Gustavus Adolphus, taking part in several important battles. He returned to England in 1632 and became a well-known figure at court, where he was admired for his wit and his wealth. Suckling entertained extravagantly and often put on lavish performances of his own plays. In 1641 he had an active part in a plot to gain control of the army for the King. Upon being discovered he fled to France, where, according to John Aubrey, he committed suicide in May or June 1642.

Many of Suckling's works were gathered together in *Fragmenta Aurea* (1646), which contained his graceful *Ballad Upon a Wedding. A Session of the Poets* (1637) comments satirically on Ben Jonson, D'Avenant, Carew, and other contemporary writers. Suckling's lyric, *Why so pale and wan, fond lover,* first appeared in his play, *Aglaura* (1637). His other plays, *The Goblins* (1638) and *Brennoralt, or the Discontented Colonel,* are also marked by fine lyrics, some of which were set to music by Henry Lawes. Unlike many writers of lyrical and occasional verse in his day, Suckling did not fall under the spell of Ben Jonson's poetry, but rather was an admirer of John Donne.

R. C. B.

**SUCRE, ANTONIO JOSÉ DE** [su'kre] (1795-1830), South American military officer and liberator, was born at Cumaná, Venezuela, Feb. 3, 1795. He began a military career early in life and at the age of sixteen was a colonel in the insurrectionary army. In 1822, acting as Simón Bolívar's agent with the rank of general, he defeated the Spanish forces at the Battle of Pichincha, thus causing the capitulation of Quito. In August 1824 Sucre routed the Spaniards at Junín in Peru, and three months later he defeated the combined Spanish forces in the famous Battle of Ayacucho. He followed up his victory by liberating all of upper Peru from Spain and by proclaiming the territory a new republic with the name Bolivia. Supreme authority over the new state was vested in Bolívar, who transferred his powers to Sucre. Although he attempted to resign, Sucre was elected first president of Bolivia in 1826. After two years, native discontent with a foreign president caused the beginnings of insurrection, and in 1828 Sucre resigned, withdrew from public affairs, and attempted a quiet life at Quito. He emerged from retirement in 1830 to act as president of a congress formed by Bolívar to insure Colombian unity. The project was not successful, and during his return to Quito on June 4, 1830, Sucre was assassinated near Pasto in Colombia. Sucre ranks today as one of the great liberators in the wars fought for independence in the northern states of South America. S. G. I.

**SUCRE,** the legal capital of Bolivia, 240 mi. southeast of La Paz on the Río Quirpinchaca, at an altitude of 8,532 ft. The city was founded as Chuquisaca by Pedro de Anzurez de Campo Redondo on Sept. 29, 1538. The name was finally changed to Sucre in honor of Antonio José de Sucre. During the Colonial period, it was the seat of the *audiencia* of Charcas. Among the famous buildings is the Basilica Metropolitana, built in the seventeenth century, which was damaged by the earthquake that destroyed much of the city in 1948. The University of St. Francis Xavier was founded in 1624. A railway connects Sucre with Potosí, 50 mi. southwest, and local air lines provide service to La Paz, Potosí, and all major cities. Pop. 1950, 40,128. S. G. I.

**SUCROSE.** *See* Sugar Chemistry.
**SUCTORIA.** *See* Animal Systematics; Protozoa.
**SUDAN.** *See* Anglo-Egyptian Sudan; French Sudan.

**SUDAN GRASS,** a sorghumlike annual, *Sorghum vulgare* var. *sudanense,* tall and slender, bearing very numerous leaves about ½ in. wide. The flowering panicle is conspicuous, being composed of many brownish spikelets, and is about a foot in length. The whole plant reaches a height of 6 to 10 ft., and closely resembles Johnson grass. It is widely cultivated for hay in the semiarid regions of Africa, where it is native, and in the extreme southern part of the United States where it is planted, to some extent, for forage.

J. C. Wis.

**SUDANIC.** *See* African Peoples.

**SUDBURY,** a city and the county town of the district of Sudbury, Ontario, Canada, about 300 mi. northwest of Toronto on Provincial Highways 17 and 69. It is served by the Canadian National and Canadian Pacific railways. Near-by Lake Ramsay has an airplane base used for general charter service for forest fire protection. Sudbury was founded in 1883 during the building of the Canadian Pacific Railway; it was incorporated as a town in 1892, and as a city in 1930. The region produces over eighty-five per cent of the world's nickel as well as important quantities of copper, gold, silver, lead, and platinum. Neither mines nor smelters are within the city limits. The city is a residential, commercial, and distributing center. It has a mining and technical school, a business college, and a college for general instruction. Pop. 1951, 42,410. D. F. P.

**SUDDEN SAWLOG,** a variety of poplar grown for quick shade and soft timber, especially in the northern parts

of the Great Plains region. It is remarkable for its vigorous, rapid growth and great hardiness; within seven years after planting by cuttings, it attains a height of 50 to 60 ft. and a trunk diameter of 8 in. The sudden sawlog is probably of Siberian origin, and is thought to be a form of the cottonwood, *Populus deltoides missouriensis,* or a hybrid from it. It is being grown experimentally as a possible source of pulpwood. J. C. Wis.

**SUDERMANN, HERMANN** [zu'dərmɑn] (1857-1928), German dramatist and novelist, was born at Matziken, in East Prussia, Sept. 30, 1857. As a youth he was apprenticed to a chemist, but was later able to study at Tilsit and Königsberg. In 1877 he moved to Berlin, where he resided the rest of his life, except for the year 1894, which he spent in Dresden. Sudermann died in Berlin on Nov. 21, 1928.

A very prolific writer of both fiction and drama, Sudermann attained a high reputation in both fields. The central intention of his novels lies in the portrayal of the life and development of individuals as distinct personalities; such social problems as form backgrounds to the stories are not the author's chief concern. On the other hand, his most important dramas are social satires, in which the characters are typical conflicting persons of recognizable strata of society.

Sudermann began his literary career as a journalist, and a journalistic vein runs through all his works, evidenced in lurid effects, sharp contrasts, and strong emotions; these, even when extreme, appealed to popular taste. He portrays the vagaries of people and society as he found them; therefore the utterances of his characters do not necessarily represent his own views nor justify the charge of inconsistency in his own philosophy of life.

Sudermann's first novel, *Frau Sorge* (1887) ("Dame Care") has remained his most popular work of fiction; next in popularity is *Der Katzensteg* (1890) ("The Cat's Bridge"; translated into English with the title *Regina*). His first drama, *Die Ehre* (1890) ("Honor"), created a great public sensation and brought him fame. Undaunted by the failure of *Sodoms Ende* (1891) ("Sodom's End," translated into English with the title, *The Man and His Picture*), Sudermann produced *Heimat* (1893) ("Home"; translated into English with the title *Magda*), his most successful play.

With the exception of two novels, *Iolanthes Hochzeit* (1892) ("Iolanthe's Wedding") and *Es war* (1894) (*The Undying Past*), Sudermann devoted himself exclusively to the stage until 1908. He produced nine dramas and seven one-act plays during this period, the most important of which are: *Das Glück im Winkel* (1895) ("The Vale of Content"), *Johannes* (1898) ("John the Baptist"), *Die drei Reiherfedern* (1899) ("The Three Heron's Feathers"), *Johannisfeuer* (1900) ("St. John's Fire"), and *Es lebe das Leben* (1912) ("The Joy of Living").

Little can be said for the novels and plays written by Sudermann in his declining years. His outstanding novel of the period is the voluminous and disreputable *Das hohe Lied* (1908) ("The Song of Songs"), which enjoyed considerable popularity in its day. Very creditable, however, are the sketches published as *Litauische Novellen* (1917) ("Lithuanian Tales"), and the charming autobiography, *Das Bilderbuch meiner Jugend* (1922) ("The Book of My Youth").
*See also* MAGDA. J. L. K.

**SUDETENLAND** [zude'tənlɑnt], geographically, the mountainous northwestern portion of Bohemia and Silesia in Czechoslovakia. Politically, the term Sudetenland, common since 1910, refers to those regions along the western frontier of Czechoslovakia which had a mixed Czech and German population. Dominated by the Sudetes Mountains, the area is noted for both its ancient and picturesque towns and its modern industrial cities. Glassmaking, brewing, and armaments are among the established industries. The history of Sudetenland has been influenced by the relation of its former inhabitants, some 3,600,000 Germans, to the Czechs living with them. This problem was settled in 1945-1946 by the removal to Germany, according to principles agreed on at the Yalta Conference, of the German-speaking inhabitants by the Czechoslovakian government.

These Sudeten Germans were partly the descendants of medieval German colonists and partly of Germans established in Bohemia in modern times by the Austrian Hapsburgs. The Sudetens had a deep consciousness of their German character and carefully preserved their language, culture, and dress. Their political organization began toward the end of the nineteenth century, when the Sudeten Germans showed a marked inclination toward Pan-Germanism. Their annexation to Germany was opposed at Versailles in 1919, and the Sudeten Germans became citizens of the Czechoslovakian Republic. Friction with the Czechs developed over language, school, and autonomy issues. Pan-German sentiment in Sudetenland contributed to the success of the National Socialists (Nazis) whose local leader, Konrad Henlein, won the support of more than 60 per cent of the German-speaking population in the elections of May 19, 1935. By June 1938, the Nazis claimed 90 per cent of the Sudeten Germans. This situation was given force by the insistent backing of Germany. When the Czech government rejected Henlein's proposal that the Sudeten Germans be given autonomy and larger cultural rights, an international crisis developed—the Munich crisis—because Germany threatened armed intervention (September 1938). A settlement agreeable to Germany, France, and England was arranged at the Munich Conference on Sept. 29, 1938. The partitioning of Czechoslovakia was authorized in order that the Sudetenland might be incorporated with Germany, and by the end of October 1939 German occupation was completed. Sudetenland was restored to Czechoslovakia in 1945. W. O. S.

**SUE, MARIE JOSEPH EUGÈNE** [sü'] (1804-1857), French novelist, was born on Jan. 20, 1804, in Paris. The son of a chief surgeon in the Imperial Guard, Eugène Sue himself saw some years of medical service in the army and navy. Having inherited a fortune on the death of his father in 1829, he resigned from the service to devote himself to literature. He began writing, in the manner of James Fenimore Cooper, stories that were faithful, dramatic pictures of seafaring life: *Kernock le pirate* (1831), *Plick et Plock* (1831), *Atar-Gull* (1831), *La Salamandre* (1832), *La Coucaratcha* (1832), and *La Vigie de Koatven* (1832). He also compiled an *Historie de la marine* (1835-37). He then turned to the novel of elegant society with *Arthur* (1838), *Le Marquis de la Létorière* (1839), and *Mathilde* (1841), and essayed the historical romance with *Lautréaumont* (1837) and *Jean Cavalier* (1840). Finally, under the impulsion of a contemporary wave of interest in socialism, he composed his two most popular novels: *Les Mystères de Paris* (1842-1843) and *Le Juif errant* (1844-1845) (*The Wandering Jew*). These two *roman-feuilletons,* or serial novels, were intended by Sue to expose the defects in the social system and helped turn public opinion toward the revolutionary ideas of 1848. Though inartistic by virtue of their negligent style, loosely constructed plots, and deliberately horrifying incidents, these

novels achieved an immense popularity among the masses, for Sue had great fertility of invention and a rare talent for dramatizing the simplest situation. In 1850, Sue was elected to the Legislative Assembly; but after the *coup d'état* of Dec. 2, 1851, he went into exile in Italian Savoy, where he died on Aug. 3, 1857. R. A. P.

**SUETONIUS (GAIUS SUETONIUS TRANQUILLUS)** [swito′niəs] (c. A.D. 70-140), Roman biographer, practiced in the law courts in his earlier years and enjoyed the friendship of Pliny the Younger. Later he became an imperial secretary under Hadrian and thus gained access to official records which were of great use to him as a writer, but in 121 he was dismissed from his secretaryship, apparently because of some failure in respect to Hadrian's wife, Sabina. Of Suetonius' biographical, historical, antiquarian, scientific, and grammatical writings, his *Lives of the Caesars,* from Julius to Domitian, has come down to us; considerable portions of the *Lives of Illustrious Men* also survive, to wit, the greater part of the section on grammarians and rhetoricians, the lives of Terence and Horace, and portions of the lives of Lucan and of Pliny the Elder. Suetonius' portraits of the Caesars are crammed with anecdotes, flattering or unflattering to their subjects, but there is no sober or consistent appraisal of character, little regard for chronology, and little political insight. G. McL. H.

**SUEVI** [swi′vai], the loosely confederated German tribes of southwestern Germany in the first century B.C. After Caesar halted the advance of the Helvetians, he defeated the Suevi (58 B.C.) under their leader, Ariovistus. Thereafter they remained quietly along the upper Rhine for over a century, until they were disturbed by the extension of the Roman frontiers by the Flavian emperors. The Suevi appear later in history as the companions of the Vandals in the invasion of Spain at the beginning of the fifth century A.D. The Suevi who went to Spain lost their identity with the coming of the Visigoths, but those who remained in the Black Forest in Germany became the ancestors of the medieval Swabians. T. B. J.

**SUEZ** [suɛ′z; su′ɛz], a city and governorate in Egypt, at the Red Sea terminus of the Suez Canal, about 75 mi. east of Cairo. It is the third port of Egypt, and a starting point for pilgrims heading for Mecca. The importance of Suez grew during World War II, especially in handling imports. The city is connected directly by rail with Cairo and Ismailia on the Suez Canal. Suez has an oil refinery and a well-developed fishing industry. Pop. 1947, 107,244. S. Van V.

**SUEZ CANAL,** one of the most important artificial waterways in the world. It crosses the Isthmus of Suez (a neck of land which connects Africa with Asia), between Port Said, on the Mediterranean, and the Gulf of Suez. Separating Egypt proper from the Peninsula of Sinai, it has a total length of 104½ mi., including 4 mi. of approach channels for the harbors. It runs nearly north and south, has a width from 310 to 525 ft. on the surface, and allows the passage of vessels having a draft of 34 ft.

**Route and Description.** The canal traverses a tract of low, sandy desert, where construction was facilitated by the Great and Little Bitter Lakes, Lake Manzala, and Lake Timsah. Both of the Bitter Lakes, which are believed to have been an arm of the Red Sea in past geological times, had their surfaces below sea level, but excavation was necessary because their depth was less than that of the canal. From Port Said to El Qantara, about 24 mi., the canal

EWING GALLOWAY

*The Suez Canal near Port Said*

passes through Lake Manzala, a shallow lagoon covering about 1,000 sq. mi. The soil of the canal area was favorable for rapid and easy excavation, and, unlike the Panama Canal, no locks were required. Drinking water is brought to the area by a fresh-water canal, which starts north of Cairo, runs northeastward to Ismailia, on Lake Timsah, and then diverges into two branches. One goes northward to Port Said, the other southward to Suez and Port Taufiq. Besides Port Said, which is situated at the canal's northern end and at what was formerly the mouth of a branch of the Nile through Lake Manzala, the only towns of considerable size on the western bank are Ismailia and Suez. Population figures in 1947 were: Port Said, 177,703; Ismailia, 68,338; and Suez, 107,244. The only settlements of importance on the eastern bank are Port Fouad, a town opposite Port Said, founded in 1926 by the Suez Canal Company as a residential quarter for its employes, and El Qantara, the starting point of the railway line across Sinai to Palestine. The canal area is connected with the Nile Valley and Delta by rail lines to Cairo from Port Said, Ismailia, and Port Taufiq. A railroad also connects it with Palestine.

**Early Canals.** The idea of connecting the Mediterranean with the Red Sea dates back to the ancient Egyptians, who constructed a boat canal from the Nile to the Red Sea in about 1300 B.C., during the time of Seti and Rameses II. This canal, which was first designed to carry fresh water from the Nile to Lake Timsah, was extended to Suez in about 600 B.C., at the time of Pharaoh Necho II. It was completed a century later and part of its original construction was used for the fresh-water canal during the building of the modern Suez Canal. Abandoned in the Byzantine era after a period of maintenance by the Ptolemies, the old canal was reopened by Amr, the Arab conqueror of Egypt under the Caliph Omar. His idea was to join the Nile with the Red Sea and supply Arabia with wheat and food. The canal he sponsored was named Khalig Amir El Muminin and was abandoned after the eighth century A.D., when the route to India was by way of the Cape of Good Hope. At the close of the fifteenth century the Venetians investigated the possibilities of a canal from the Mediterranean to the Gulf of Suez. They had found that the Cape route affected their trade adversely, but the idea of the shorter Suez route was not carried out. Early in the nineteenth century the overland route to India was established across Egypt, via the Nile to Cairo, and then by camels to Suez. Later, a proposal to cut a direct canal across the isthmus to avoid the delay and expense of the land journey was declared impossi-

ble by Lepère, the French engineer commissioned by Napoleon Bonaparte to survey the project. He based his view on erroneous measurements; however, British engineers later reported the practicability of building the canal.

**Modern Canal.** In 1854, Ferdinand de Lesseps, the French engineer, succeeded in obtaining from Said Pasha, the Wali of Egypt, a concession to establish La Compagnie du Canal Maritime de Suez. This was formed in 1858, with a capital stock of 200,000,000 francs, or about $40,000,000, in 500-franc shares. De Lesseps at first met the greatest opposition from Great Britain, which, ironically, in view of its present dependence upon the canal, tried to persuade the Sultan against the project. The work on the canal was begun in April 1859, along with work on a fresh-water canal from Cairo by way of Ismailia, which was essential to the construction. By the terms of the original concession, Egypt was to receive 15 per cent of the gross receipts for ninety-nine years, after which the canal was to be handed over to the Egyptian government. Most of the early canal shares were bought by the French, Turks, and Said Pasha, who helped the company by purchasing nearly half the stock. The Khedive Ismail refused to accept the continuance of forced labor in 1863, and this led to the arbitration of Emperor Napoleon III, by which Egypt had to pay 80,000,000 francs. In 1875, Disraeli, the British Prime Minister, bought 176,602 shares for £4,000,000 from the Khedive Ismail, who was obliged to sell because of financial difficulties. After that date British interest in the Suez Canal and Egypt increased, until at present, the British own 295,026 shares out of a total of 652,932.

The canal was opened to navigation in November 1869, after great ceremonies at Port Said and Ismailia. The project had taken ten years to complete and the total cost was £29,725,000. As originally constructed, the waterway had a depth of 26.05 ft. and a bottom width of 72 ft., but, with the increase of traffic, enlargement was needed to accommodate ships drawing 34 ft. The average time of transit through the canal was decreased from three days in 1869 to 11 hr. and 20 min. in 1939. This was for vessels navigating by night as well as by day.

**Commercial Importance.** The opening of the canal in 1869 revolutionized the world shipping picture, particularly in the Mediterranean and the Indian Ocean. The distance between western Europe and India was reduced by nearly 5,000 mi., and the journey itself was shortened by fourteen days. In addition, the canal, with more traffic from south to north than from north to south, was an aid in increasing such exports from India and Australia to Europe as rice, oil seeds, tea, wheat, wool, jute, and rubber. Other effects were reduction of the prices of Far Eastern goods in Europe, encouragement for the development of steamships, and greater importance for the ports of the Mediterranean. When the canal was opened, toll for the passage was 10 francs per passenger and 10 francs per ton, but this has been reduced several times, and no toll is now levied on persons. The following table shows the number and net tonnage of the vessels that have passed through the canal, and the gross company receipts in selected years between 1870 and 1953:

| *Year* | *Vessels* | *Net Tonnage* | *Receipts in Francs* |
|---|---|---|---|
| 1870 | 488 | 436,609 | 5,159,327 |
| 1900 | 3,441 | 9,738,157 | 90,623,608 |
| 1912 | 5,373 | 28,275,120 | 134,762,199 |
| 1935 | 5,953 | 32,727,592 | 927,746,902 |
| 1939 | 5,222 | 29,265,344 | 1,491,635,891 |
| 1950 | 11,751 | 81,795,523 | 2,670,810,911 |
| 1953 | 12,731 | 92,905,439 | 2,893,243,244 |

The number of passengers, both civil and military, who went through the canal in 1940 was 98,944; in 1948, it was a record 610,951. As a result of the high tolls, the Suez Canal Co. pays high dividends to shareholders.

**Political and Strategic Importance.** The Suez Canal is owned and controlled by a commercial company, incorporated and domiciled in Egypt and subject to Egyptian laws. The canal is not fortified, but the British, according to the Anglo-Egyptian treaty in 1936, were granted the right to station troops and planes there for twenty years. This was a matter of extended controversy between the Egyptians and the British for some years, and was solved in 1954 when the British agreed to remove their troops. The canal is open to all nations and is free from blockade, according to terms of the convention of Constantinople, which was signed on Oct. 29, 1888, by Great Britain, the Austro-Hungarian Empire, France, Germany, Italy, the Netherlands, Russia, Spain, and Turkey. The freedom of passage has only theoretical value, however, for Egypt controls the approaches. Thirty-two directors of the governing board are distributed as follows: 16, French; 9, British; 1, Dutch; 5, Egyptian; 1, American. In 1948 Somerville Pinkney Tuck, American Ambassador to Egypt, resigned that post to become the first American member of the Suez Canal Board. Two additional Egyptian directors were added in 1949, 2 more were appointed in 1954, and by 1968 Egypt will be represented by 17 directors. During World War II the canal was obstructed only for short periods, but the value of the canal proper for navigation was limited chiefly to the movement of British warships between the Mediterranean and the Red Sea. This was because the Mediterranean, as a theater of war, was unsuitable for commercial traffic. While the strategic value of the canal has decreased in the present day of air warfare and guided projectiles, its importance to peacetime maritime commerce is as great as ever. S. Van V. and W. S. V.

**SUFFOLK, EARLS OF.** *See* HOWARD.

**SUFFOLK** [sʌ′fək], a county on the east coast of England, bounded on the north by Norfolk, on the west by Cambridgeshire, on the south by Essex, and on the east by the North Sea. It covers an area of 1,482 sq. mi. of flat terrain, most of it less than 100 ft. above sea level, and is drained by the rivers Stour, Orwell, Waveney, Deben, and Alde. The county is composed of the two districts of East and West Suffolk, which, together with Norfolk, constitute East Anglia. Ipswich is the county town of East Suffolk, and Bury St. Edmunds is the shire town of West Suffolk.

Originally part of the kingdom of Iceni, Suffolk was ravaged by the Romans. Near the village of Mildenhall, Roman ornamental silver, a treasure of incalculable worth, was unearthed in 1946. The remains of Anglo-Saxon settlements are still to be seen. In the fifth century, Suffolk was the center of the kingdom of the Angles, and its medieval history is attested by the Norman churches at Walton and Walsoken. After the Conquest, Suffolk became a separate shire, and during the civil wars Mary Tudor raised an army there. For several centuries, Suffolk was among the most populous English counties, the cloth industry then providing a prosperous livelihood. Today the principal occupations are the raising of cereal crops, dairying, breeding the famous "Suffolk punch" draft horses, and fishing. Suffolk returns four members to Parliament. Pop. 1952, 453,500. B. Su.

**SUFFOLK,** a city in southeastern Virginia, county seat but independent of Nansemond Co., on the Nansemond River.

Peanuts, corn, and cotton are the leading crops of the region. The city is said to be the largest peanut market in the world. Founded about 1740, Suffolk was incorporated as a town in 1808 and as a city in 1910, and has the council-manager type of government. During the Civil War, Suffolk was in the hands of the Union troops. Transportation is afforded by the Seaboard Air Line, the Atlantic Coast Line, the Norfolk and Western, the Virginian, and the Atlantic and Danville railroads. Industries manufacture peanut products, cotton, lumber products, bricks, hosiery, fertilizer, overalls, confectionery, and packed meat. Pop. 1950, 12,339.

**SUFFRAGAN** [sʌ′frəgən], a title used of a diocesan bishop in relation to his archbishop, and of an assistant bishop, with limited powers, to a diocesan bishop. In the Anglican Church a suffragan bishop in the latter sense is distinguished from a bishop coadjutor in that the latter has the right of succession, when the diocesan dies or resigns, while a suffragan bishop does not possess this right. In the Church of England, a suffragan bishop may also hold a pastoral cure in the diocese to which he is appointed, but in the American Episcopal Church this is not allowed.

L. C. L.

**SUFFRAGE,** the right or privilege of voting. Suffrage is theoretically and historically associated with democratic political processes, especially as they are practiced in a system of representative government.

Two underlying theories of the franchise can be distinguished. (1) The vote is an inalienable right inhering from the rationality and moral perfectability of man. Originating in the popular sovereignty and natural rights theory of the eighteenth century, this concept of the franchise has been generally discredited. It has, nevertheless, furnished the ideological impetus for extending the franchise to an ever-widening electorate. (2) The vote is a political privilege, a function of government, conferred upon the individual by law and subject to qualifications which the governing authority may deem appropriate. This theory predominates in modern electoral systems, and the history of the franchise has been less a matter of questioning privilege as the basis for the vote than of liberalizing the disfranchising qualifications.

In the ancient world of Greece and Rome voting was an integral function of citizenship. All adult male citizens were equally entitled to the vote by reason of their citizenship. This practice prevailed among the Germanic folk tribes of the early Middle Ages and was briefly resurrected in the city states of the Italian Renaissance. With the rise of feudalism and a highly stratified social structure the vote became a prerogative of privileged status, a vested interest arising from membership in an estate and based principally upon ownership of land. Property ownership as a qualification for suffrage survived well into modern times and was expressed in weighted, or plural, voting. It characterized the electoral systems of imperial Russia and Germany, was finally abolished in Great Britain only in 1918, and still exists in Bolivia and Ceylon.

The growth of political democracy in the nineteenth and twentieth centuries resulted in an expanding franchise. Barriers of religion, property, race, and sex were steadily reduced, and there was a general movement toward universal adult suffrage. In Great Britain, the reforms of 1832, 1867, and 1884 gradually extended the suffrage to all adult males. Patriotic service during World War I and years of organized agitation were rewarded in 1918 when women over thirty received the franchise. Women were accorded equal suffrage rights in 1928 when the voting age was lowered to 21. In 1928, 60 per cent of the British population was entitled to vote, as compared with 4 per cent in 1831.

Voting in the United States is subject to state, not Federal, regulation. Except as limited by Constitutional amendment, each state is free to determine the electoral qualifications of its population. By the middle of the nineteenth century the enfranchisement of all adult white males was substantially achieved as property and religious limitations were rescinded. The Fifteenth Amendment (1870), which invalidated all abridgements due to "race, color, or previous condition of servitude," extended the suffrage to the Negro. The Nineteenth Amendment (1920) prohibited denial of suffrage because of sex.

Some indication of the progress made toward universal suffrage in recent times may be garnered from the following facts. Before World War I only a handful of countries (Scandinavia, New Zealand, and Australia) permitted women to vote. By 1928 only Spain, Italy, France, China, and Japan, among the great powers, withheld the ballot from women. After World War II new constitutions in France (1946), Italy (1947), China (1947), and Japan (1946) provided for woman suffrage. A few countries in Latin America (Mexico and Colombia) and the Near East (Egypt and Syria) and Switzerland still resist the trend and grant suffrage solely to males.

The expansion of communism has not proved incompatible with the movement toward a broadening electorate. Despite their dictatorial basis, Communist regimes utilize representative forms of government. The constitutions of the Soviet Union and the Communist states of Eastern Europe provide for universal and equal suffrage.

Requirements of citizenship, age, residence, and registration are limitations of the franchise which are almost universally observed. All nations require citizenship of their electorates, although the Soviet Union for a time permitted foreigners to vote in its elections. Residence and registration regulations are considered necessary to counteract fraudulence. Most countries have established twenty-one as the legal voting age, although in others the age varies from eighteen (in many countries) to twenty-five (Denmark). Traitors, certain kinds of criminals, and the mentally unsound are generally debarred, and in many countries bankrupts and members of the clergy, police, and armed forces are similarly denied the ballot. Literacy tests (in the Philippine Islands, Turkey, Chile, and eighteen states in the United States) and poll taxes (in seven states in the United States) are additional methods for measuring the acceptability of voters.

The development of modern transportation, the expansion of business across state and national frontiers, and the itinerancy of college students have emphasized the need for some form of absentee voting lest large numbers of qualified voters be disfranchised solely by virtue of absence from their locality. This problem was highlighted during World War II when millions of eligible voters were in the armed services. Many countries have tailored their electoral regulations to permit absentee voters to cast ballots. All but five states in the United States have absentee voting provisions, and three of the five permit absent servicemen to vote.

One of the most vexing problems of the suffrage is the extent to which eligible voters stay away from the polls on election day. In the United States only 50 to 70 per cent, on the average, of the electorate exercises its voting rights. In other democratic states the vote rarely exceeds 80 per cent and frequently dips as low as 60 per cent. Totalitarian states

regularly have turnouts only fractionally removed from 100 per cent, but it is reasonable to assume that compulsion, direct or indirect, is primarily responsible for the high vote. Some states (Belgium, Bolivia, and Uruguay) have tried to remedy this malaise by enacting legislation that makes voting obligatory and penalizes the nonvoter. Belgium has had a compulsory voting law since 1893, and as a result voting delinquency has been low, averaging between 5 and 10 per cent. Yet it is questionable whether compulsory voting attacks the evil of apathy and ignorance at the source. The need is not merely for a larger but, more important, for a better informed and more intelligent electorate. The solution seems to lie rather in a more vigorous program of civic education. C. Ro.

**SUFISM** [su'fɪzəm], the general name for Islamic mysticism. The term first appeared in Arabic writings in the middle of the ninth century of the Christian Era and was applied to a class of ascetics. The name Sufism is derived from Arabic *"sūf"* ("wool"), referring to the ascetic practice of wearing wool.

Sufism's beginnings, which are very obscure, took place during the eighth century. Sufism was, indeed, more of an emotional pattern than it was a set of disciplines and doctrines. It has often been described as a rebellion against Islam's intellectualism and the formalism that grew from the Koranic emphasis on the power and arbitrary sovereignty of Allah, but the early Sufis found support for their views in the Koran, quoting the passages: ". . . rely upon God, for God is guardian enough (33:47) . . . Be ye glad then in the covenant which ye have made with Him, for that is the mighty happiness. Those who repent, those who worship, those who praise, those who fear, those who bow down, those who adore . . . glad tidings to those who believe" (9:113-114).

Sufism is a response to the deep human aspiration for a personal relation with God and an immediate awareness of truth. Its purpose was to gain insight into the Divine Being, and the Sufi mystics maintained vigils, practiced contemplation, and experienced ecstasies.

Sufism gradually acquired large-scale significance; the symbols, orders, and cults, particularly in Persia, were popularized by the poets; and eventually Sufism became the central core of religious thought in the Moslem world. There was initiated through Sufism in the twelfth century a vast reorganization of the life of Islam, corresponding to the monastic orders of medieval Christendom.

As it grew, Sufism became a syncretic movement. The practice of wearing wool was copied from Christian monks, as were the customs of celibacy and nocturnal meditation; the Christian pattern of clergy-neophyte is evident in the *shaykh-murid* relationship; church litanies became a pattern for Islam's very elaborate ritual; the *tarīqat* (path) corresponds to the fraternity or order; and converts from Judaism and Christianity introduced such motifs as the antichrist.

Greek influence appeared in the belief, adopted by Islam, that ecstacy is a means for the attainment of divine knowledge. There are Hellenistic influences in Sufi theosophy, and the later schools show pantheistic traits derived from Buddhism and from Vedantic sources. For all its borrowings from other religions, however, it is noteworthy that Sufi mysticism takes its chief characteristics from Islam.

Sind is the home of Indian Sufism. The Moslems of Pakistan take kindly to the mystic cult, three fourths of them belonging to one of the four leading orders: the Chishtiyah and Suhrawardiyah, the Qadiriyah and Naqshabandiyah. Though generally quiescent in many a Moslem country, Sufism is by no means extinct in the modern world of Islam. E. J. J.

**SUFU.** *See* KASHGAR (SUFU).

**SUGAR AND CONFECTIONERY INDUSTRIES.** *See* FOOD INDUSTRIES.

**SUGAR BEET,** a biennial plant of the goosefoot family, grown as a source of sugar and for stock food. It may have been developed from the garden beet, *Beta vulgaris,* though not all botanists hold this opinion. The roots resemble those of the intermediate varieties of garden beet, but are white or yellowish, and somewhat larger. During the last century the sugar content of the sugar beet has, by breeding and selection, been increased from 7 per cent to as high as 24 per cent for the individual roots. Average yields are about 12 tons of beets, containing 2 tons of sugar, to the acre, though these are often exceeded to 10 or 20 per cent. Sugar yields of the roots have increased at the same time that the weight of roots necessary to produce a pound of sugar has been cut in half. These factors have made the crop profitable in both Europe and America, although land on the Continent is expensive, and the cost of labor in the United States is high. Sugar beets thrive best in cool climates and in well-drained, deep, rich loams. These are found in central Europe and northern and western United States and adjacent Canada. Sugar beet factories are expensive to erect and operate, hence suitable soils and near-by supplies of labor have been considerations in establishing such industries; the organizations usually maintain a staff of specialists to teach the growers how to produce good crops. V. A. T.

**SUGAR CANE,** a member of the grass family, *Saccharum officinarum.* Sugar cane is a coarse perennial and, because it yields cane sugar, one of the most important plants in the world. It is presumed to be a native of Asia or the East Indies, but, since the parent wild species has never been discovered, sugar cane is probably a cultigen. The Greeks and Romans had a somewhat vague knowledge of a reed from which the Hindus obtained sugar, for such a plant is mentioned in the writings of Strabo (c. 60 B.C.), Dioscorides (first century A.D.) and Pliny (A.D. 23). During the Middle Ages, sugar cane was brought by the Arabs into Egypt, Sicily, and Spain, where its cultivation flourished and remained important until large sugar plantations were developed in the American colonies. Sugar cane was introduced into Brazil about 1500, and soon afterwards to Mexico. It is now cultivated in most warm regions, especially in the East and West Indies, Brazil, Hawaii, and parts of Africa.

COURTESY OF BELGIAN GOVERNMENT INFORMATION CENTER

*Hoisting sugar cane at a sugar refinery in the Belgian Congo*

The plant has solid jointed canes, bears long stiff leaves, and has a large terminal flowering panicle. It flowers freely, but rarely sets seed in the tropics. It does not bloom in the United States. For commercial production, sugar cane is propagated by stem cuttings.

In the United States, sugar cane is grown from Texas to South Carolina, but in most of the states it is used for syrup only. Sugar is refined from it in Louisiana and Florida. Louisiana's cool weather makes it necessary to harvest the cane in an immature condition. The juice is therefore impure, containing a high amount of reducing sugar, and it is relatively low in sucrose. *See also* GRASSES; SORGHUM. C. K. H.

**SUGAR CHEMISTRY.** Sugars are a group of chemical compounds characterized by the following similarities: they are usually white, crystalline, are soluble in water, slightly soluble in alcohol, and insoluble in organic solvents. Most have varying degrees of sweetness. They have, with few exceptions, the empirical formula $C_m(H_2O)_n$, hence the generic name hydrate of carbon, or carbohydrate. Starch, dextrin, and cellulose are also carbohydrates. The sugars have one or more asymmetric carbon atoms; this structure gives them the property of rotating polarized light, or optical activity, a property used extensively in the analysis and characterization of sugars.

It is convenient to classify the sugars into two groups, with their subdivisions, as follows:

1. Monosaccharides
   - (*a*) Aldoses
   - (*b*) Ketoses
2. Oligosaccharides
   - (*a*) Disaccharides
   - (*b*) Trisaccharides
   - (*c*) Tetrasaccharides

## MONOSACCHARIDES

**Structure.** *Aldoses.* The aldose monosaccharides, for simplicity of discussion, may be considered as straight-chain carbon compounds having an aldehyde group at one end and a primary alcohol group at the other, with one hydroxyl and one hydrogen attached to each of the intermediary carbons. Thus, an aldohexose is $CH_2OH \cdot (CHOH)_n \cdot CHO$.

*Ketoses.* The ketose sugars may be considered as straight-chain compounds with a primary alcohol group at each end of the chain and a ketone group, usually at carbon 2. Thus, a ketohexose is $CH_2OH \cdot (CHOH)_3—CO—CH_2OH$. There are four *d*-ketohexoses: psicose, fructose, sorbose, and tagatose. Each is structurally related to an epimeric pair of aldohexoses, the asymmetric carbon 2 of the aldose structure becoming a carbonyl group, C=O, whereas the configuration of the remaining three asymmetric carbons remains the same. Thus *d*-psicose is structurally related to *d*-allose and *d*-altrose, *d*-fructose to *d*-glucose and *d*-mannose, *d*-sorbose to *d*-gulose and *d*-idose, and *d*-tagatose to *d*-galactose and *d*-talose.

**Chemistry of the Monosaccharides.** *Chemical Properties.* Both the aldoses and ketoses are easily oxidized and hence act as reducing agents. They reduce ammoniacal silver nitrate to form a silver mirror, and warm alkaline copper solutions to cuprous oxide, a reaction widely used in the analysis of molasses and other sugar products. On mild oxidation with $Cl_2$ or $Br_2$, monobasic acids with the same number of carbon atoms are formed, the aldehyde end of the molecule being oxidized to carboxyl:

$$CH_2OH(CHOH)_nCHO \rightarrow CH_2OH(CHOH)_nCOOH$$

With strong oxidizing agents such as nitric acid, both ends of the carbon chain are oxidized to give a dibasic acid, while at the same time much of the acid is further oxidized to oxalic acid and carbon dioxide:

$$CH_2OH(CHOH)_nCHO \rightarrow COOH(CHOH)_nCOOH$$

The oxidation of sugars and especially sugar derivatives with periodic acid is an interesting case of specialized oxidation. Periodic acid oxidizes only adjacent hydroxyl groups to aldehyde groups. If three or more hydroxyl groups are adjacent, the intermediate ones are oxidized to formic acid. Hudson and his collaborators have used this reaction to great advantage in structural studies in the sugar group.

In alkaline solution a pair of epimeric aldose sugars and the structurally corresponding ketose are mutually interconvertible. Thus, starting with a weak alkaline solution of glucose, mannose, or fructose, all three will be found present after some hours at room temperature. In strong alkaline solution the reducing sugars undergo more drastic changes, a series of compounds called saccharinic acids being formed. In alkaline solution in the presence of air or oxygen, carbon dioxide, lactic acid, and a whole series of hydroxy acids may be formed. In cold dilute acid solution the sugars are quite stable, but heating with 12 per cent HCl results in a quantitative production of furfural from the aldopentoses, whereas aldohexoses yield hydroxy-methyl-furfural and levulinic acid.

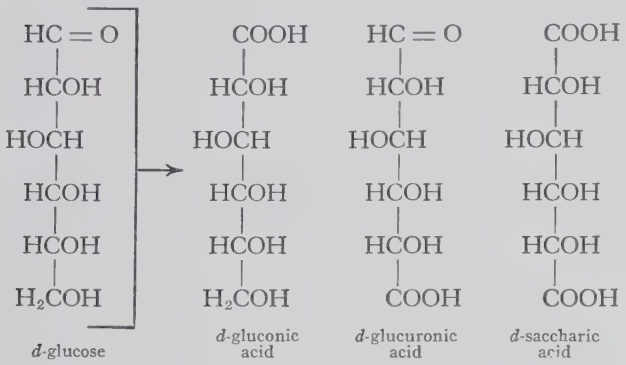
Since the aldose sugars possess both aldehydic and alcoholic groups, they react to some extent both as aldehydes and alcohols. As aldehydes they act as reducing agents, form oximes with hydroxyl amine, and phenylhydrazones with phenylhydrazine. When they are heated with an excess of phenylhydrazine, very insoluble compounds called phenylosazones are formed. In this reaction two eperimeric sugars and their structurally related ketose give the same phenylosazone. Thus, glucosazone is formed from glucose, mannose, or fructose. This osazone reaction is extremely valuable for identifying the sugar or sugars in a solution; Emil Fischer used it extensively in his epoch-making researches resulting in the elucidation of the configurational relationships of the simple sugars. As aldehydes the sugars may be readily oxidized to monobasic acids or reduced to the so-called sugar alcohols. In keeping with their alcoholic properties the sugars form esters with acids, acetals and ketals with aldehydes and ketones, and may be made to react with methyl iodide or dimethyl sulphate to give methylethers.

*Glycosides.* Of special interest in sugar chemistry is the reactivity of carbon 1. The hydroxyl attached to this carbon may be readily substituted by an aldoxy group to form the glycosides. These compounds are more stable than the parent sugars, since they are not so readily oxidized or reduced. They exist, as do the parent sugars, in $\alpha$ and $\beta$ modifications. When the hydroxy groups of the sugar molecule are protected, as by acetylation or benzoylation, the group on C1 may be replaced by a halogen, thus giving an extremely labile compound that will react with other sugars or hydroxylated compounds to form new sugars or new glycosides.

*Degradation and Synthesis.* The carbon-chain length of a reducing sugar may be increased or decreased. The cyanohydrin reaction is the classic method for increasing the chain length. Hydrogen cyanide may be added to reducing sugars to give nitriles which can be hydrolyzed to sugar acids, which may in turn be reduced to sugars having one more carbon in the chain than the original. By this synthesis a new asymmetric carbon atom is introduced, so that two isomeric sugars are formed from the one of lower carbon content. Several methods are employed for degrading a sugar to one of lower carbon content. Probably the simplest method is by oxidation of the calcium salt of the sugar acid with

hydrogen peroxide and ferric acetate. Since this is the reverse of the building-up reaction, either of two epimeric sugars will give one and the same sugar of one less carbon content. Thus, either glucose or mannose will be degraded to arabinose.

**Derivatives of the Monosaccharides.** *Acids.* Three types of sugar acids may be considered as derivatives of the aldose sugars by oxidation of the terminal groups on C1, C6, or both. For example, from glucose there may be derived two monobasic and one dibasic acid as formulated below:




*d*-glucose — *d*-gluconic acid — *d*-glucuronic acid — *d*-saccharic acid

The "onic" acids such as gluconic exhibit two properties of exceptional interest. They readily lose one molecule of water, forming lactones which crystallize readily. When they are heated to a high temperature with pyridine or quinoline, a rearrangement of the hydroxyl on C2 takes place to give an equilibrium mixture of the original acid and a new epimeric acid. For example, *d*-arabonic acid may be partially converted to *d*-ribonic acid, a reaction that has been extremely valuable in the synthesis of the vitamin riboflavin. The uronic acids, galacturonic and mannuronic, are building blocks for the naturally occurring substances pectin and alginic acid, respectively. Glucuronic acid is a scavenger in the animal body, uniting with certain types of poisonous substances and eliminating them by way of the urine.

*Alcohols.* By reduction of the terminal group on C1 for aldoses or the C2 group for ketose sugars, compounds are formed whose only functional groups are primary and secondary alcohols. This reduction is readily carried out with sodium amalgam or with hydrogen and a nickel catalyst. Many of these sugar alcohols are naturally occurring products. Sorbitol, from glucose or fructose, and mannitol, from mannose or fructose, are produced industrially for a wide variety of uses. Sorbitol is especially valuable as a raw product in the manufacture of vitamin C, ascorbic acid.

*Esters and Ethers.* The sugars are readily acetylated, propionated, benzoylated, and reacted on otherwise to form ester-type compounds, all the hydroxyl groups in the molecule take place in the reaction. These products are usually well-defined crystalline compounds. These derivatives of the reducing sugars exist in alpha and beta forms, as do the parent sugars. The acetates, benzoates, and toluene sulphonates have been valuable in synthetic-sugar chemistry. Glucose phosphate has been of particular interest, serving as the basis for the biological synthesis of starch and sucrose. With a few exceptions only the methyl ethers of the sugars, the methyl sugars, have been prepared. The reducing sugars cannot be directly methylated, but on treatment of the glycosides with methyl iodide and silver oxide or with dimethylsulphate, methyloxy groups are substituted for the primary and secondary hydroxyls. An extensive series of these methyl sugars has been prepared, such as 3-methyl glucose, 2-3-6-trimethyl glucose, 2-3-4-6-tetramethyl glucose, and so on. The importance of these methyl sugars in carbohydrate research and synthesis cannot be overestimated. Until their discovery and development, the advancement of certain phases of sugar, starch, and cellulose chemistry was at a standstill. No method was available for determining the ring structure in the monosaccharide units or the point of attachment of the monosaccharide units in compound sugars or polysaccharides. These methylated sugars have been the keys with which the organic chemist has unlocked many problems of carbohydrate structure.

*Anhydro Sugars.* As the name implies, anhydro sugars are those from which one molecule of water has been eliminated, by dry distillation or otherwise. The compounds fall into three classifications:

(1) Ethylent oxide type, in which the anhydro group is between C2 and C3, C4 and C5, or C5 and C6.

(2) Butylene oxide type, in which water has been eliminated between C2 and C5 or C3 and C6.

(3) Glucosan type, which may be three-, four-, five-, or seven-member ring compounds. The 1-6 anhydro sugars are easily hydrolyzed by acids, a property that makes them useful in the synthesis of various sugar derivatives. Mannosan has been used for the synthesis of disaccharides.

*Desoxy Sugars.* Desoxy sugars are exceptions to the general rule that the empirical formula for sugars is $C_m(H_2O)_n$. As the name implies, desoxy sugars are substances containing one less oxygen than is normally the case for a sugar compound. The desoxy sugars are of two types:

(1) The 2-desoxy sugars, in which the oxygen in the secondary alcohol on C2 is missing, as in desoxy glucose, $CH_2OH—(CHOH)_3—CH_2—CHO$.

(2) The methyl pentoses, in which the oxygen of the primary alcohol on C6 is missing, as in rhamnose, $CH_3(CHOH)_4—CHO$.

Both these types of sugars occur in natural products.

*Amino Sugars.* These sugars are aldohexoses in which a secondary hydroxyl has been replaced by an amino group ($NH_2$). Two occur extensively in natural products, namely, glucose amine or 2-amino glucose, and chondrose amine or 2-amino galactose. The former is obtained by hydrolyzing chitin from crab shells with strong HCl, whereas the latter may be obtained by the hydrolysis of nasal cartilage, tendons, and similar tissues. Other amino sugars, such as 3-amino glucose and 6-amino glucose, have been prepared by synthetic means.

**Individual Monosaccharides.** The naturally occurring or most important members of this group are described individually.

***Aldopentoses.*** d-*Ribose.* *d*-Ribose occurs in yeast nucleic acid and is important for the synthesis of the vitamin riboflavin.

l-*Arabinose.* *l*-Arabinose is widely distributed in plant products, especially in gums. It does not occur as the free sugar but is found in the polymeric araban.

d-*Arabinose.* *d*-Arabinose does not occur naturally but is readily prepared from *d*-glucose by the degradation reaction described earlier.

***Aldohexoses.*** d-*Glucose.* *d*-Glucose is the most important of all aldehyde sugars. It is the building block of starch and cellulose. It occurs in the free state in most fruits, vegetables, and plant juices. It is the sugar of blood, causing death if deficient and diabetes if superabundant. It is food for man, beast, and insects. It is fermentable by yeasts, bacteria, and fungi. The United States Pharmacopoeia (U.S.P.) designation for *d*-glucose is dextrose.

d-*Mannose.* *d*-Mannose occurs widely in nature as the

polymeric mannan. It is fermentable by yeasts but is not an important raw product for alcoholic fermentation. Pure mannose is said to have a slightly bitter aftertaste, in marked distinction to the pure sweet taste of other sugars.

d-*Galactose.* *d*-Galactose occurs in the polymeric galactan, abundant in the western larch and in a large number of natural gums. As a galactoside it is found in brain tissue, and combined with glucose it forms the disaccharide lactose, or milk sugar. Galactose has no important industrial uses, but by oxidation with nitric acid the relatively insoluble mucic acid, a potentially useful organic acid, is formed.

***Ketohexoses.*** d-*Fructose.* *d*-Fructose occurs in a great many fruits, plant juices, and saps. Combined with *d*-glucose it forms the easily hydrolyzable disaccharide sucrose. Since sucrose is so readily hydrolyzed by acids and enzymes, the products of its hydrolysis, *d*-glucose and *d*-fructose, generally occur at least in small quantities wherever sucrose is found. The mixture of equal parts of *d*-glucose and *d*-fructose is called invert sugar, which is the main constituent of honey. Fructose is the building block of the polysaccharide inulin, from which it may be obtained by acid hydrolysis. Fructose is said to be sweeter than sucrose, but cost of manufacture has hampered its commercial development.

**l-*Sorbose.*** *l*-Sorbose is found in the berries of the mountain ash, where it is probably produced by bacterial oxidation of *d*-sorbitol, a natural constituent of the berries. *l*-Sorbose is produced in quantity by bacterial fermentation of *d*-sorbitol for use as an intermediary product in the production of *l*-ascorbic acid, vitamin C.

## OLIGOSACCHARIDES

The oligosaccharides are subdivided into three groups: (1) disaccharides, (2) trisaccharides, and (3) tetrasaccharides, which, as their names imply, are composed of two, three, or four monosaccharide units. These relatively simple compound sugars may be called oligosaccharides, to distinguish them from the group of more complex, high-molecular-weight sugar polymers, such as starch, inulin, and cellulose, known as polysaccharides. The monosaccharide composition of the oligosaccharides was readily determined, and in those cases where a disaccharide does not display aldehydic or ketonic reactions the attachment must be between C 1 and $C^1$ 1 for two aldose monosaccharides or between C 1 and $C^1$ 2 for an aldoseketose combination. Until the introduction of the methylation reaction, little further could be learned concerning the structure of the compound sugars. However, by application of this reaction and by study of the methylated sugars and of their hydrolytic, oxidation and degradation products, within a few years the structure and configuration of many of the compound sugars was made clear. Column 3 of the table indicates the configuration of the sugar and the point of attachment of the monosaccharide units. Arabic numerals are used to denote the point of attachment of the nonglycosidic monosaccharide, which in the case of the reducing disaccharides is the component still possessing aldehyde properties, with C 1 of the other hexose component. The Greek letters alpha and beta denote the configuration of the glycosidic carbon.

Common Oligosaccharides

| *Name* | *Composition* | *Configuration* |
|---|---|---|
| Sucrose | Glucose<>fructose | 1-α-Glucoside-2-β-fructose |
| Trehalose | Glucose<>glucose | α, α-Diglucose |
| Maltose | Glucose<glucose< | Glucose-4-α-glucoside |
| Cellobiose | Glucose<glucose< | Glucose-4-β-glucoside |
| Gentiobiose | Glucose<glucose< | Glucose-6-β-glucoside |
| Lactose | Galactose<glucose< | Glucose-4-β-galactoside |
| Melibiose | Galactose<glucose< | Glucose-6-α-galactoside |
| Turanose | Glucose<fructose< | Fructose-3-α-glucoside |
| Raffinose | Galactose<glucose<>fructose | 2-β-fructose-1-α-glucose-6-α-galactoside |
| Melezitose | Glucose<fructose<>glucose | 1-α-glucose-2-β-fructose-3-α-glucoside |
| Gentianose | Glucose<glucose<>fructose | 2-β-fructose-1-α-glucose-6-β-glucoside |
| Stachyose | Galactose<galactose<glucose<>fructose | |

**Sucrose.** Sucrose is by far the best known of all the sugars, produced annually from sugar cane and beets by the millions of tons, and to a less extent from maple sap and certain species of palm trees. It possesses no aldehyde or ketonic properties, hence does not show mutarotation or reduce Fehling's solution. It is stable in dilute alkalies but is readily hydrolyzed by dilute acids or the enzyme invertase to a mixture of equal parts of *d*-glucose and *d*-fructose, called invert sugar.

**Trehalose.** Trehalose, another nonreducing disaccharide, is found in certain fungi which contain no chlorophyll. The best source of this sugar is the resurrection plant, which grows abundantly in southwest North America.

**Maltose.** Maltose is a dissaccharide which, though seldom encountered in the crystalline form, is a close competitor of sucrose in the matter of human happiness and well-being. It is a hydrolytic product of starch and is one of the principal components of confectioners' glucose or corn sirup, and the principal component of a new and sweeter type of corn sirup called sweetos. Maltose is a reducing sugar and shows the characteristic reactions of aldose sugars.

**Cellobiose.** *Cellobiose* sugar is an intermediate in the breakdown of cellulose to glucose, thus a unit of the cellulose molecule as maltose is a unit of starch.

**Gentiobiose, Melibiose, Turanose.** *Gentiobiose, melibiose,* and *turanose* are disaccharide portions of the trisaccharides gentianose, raffinose and melezitose, respectively, and are prepared by the hydrolysis of these sugars. Gentiobiose has been identified as a product of the drastic hydrolysis of starch, but melibiose and turanose have been obtained only by the hydrolysis of their respective parent trisaccharide. Gentiobiose and melibiose are aldehyde sugars, whereas turanose is ketone sugar.

**Lactose.** *Lactose,* a disaccharide occurring as a major constituent of milk, is an important article of diet. It crystallizes readily and can be easily prepared from whey. However, the pure crystalline product until recently has not been extensively used except in prepared infants' food. With the extensive manufacture of penicillin, the demand for pure lactose greatly increased. It is a major item in the mash for the fermentive production of this antibiotic. Lactose is found exclusively in the animal kingdom in contrast to all other sugars, which are of purely vegetable origin.

**Raffinose.** *Raffinose* is a trisaccharide which occurs extensively in sugar beets and in seeds, leaves, roots, and plant exudations caused by insect injury. Cottonseed is a particularly rich source. It is a nonreducing sugar, stable in alkaline solution; but since a portion of the molecule is the disaccharide sucrose, it is readily hydrolyzed, yielding fructose and melibiose.

**Melezitose.** Melezitose is a trisaccharide that occurs as an exudation or manna on the bark, leaves, and twigs of a number of trees, especially evergreens such as the Douglas fir and pines. Under certain climatic conditions it occurs so extensively that bees collect it, probably by mistake, and deposit it in the comb. Being a sugar of low solubility, it crystallizes

in the honey, forming a product with little sweetness and of a gritty consistency, to the distress of the commercial apiculturist. Melezitose is another nonreducing sugar. Since it contains the sucrose linkage, it is rather easily hydrolyzed to turanose and glucose.

**Gentianose.** Gentianose comprises about 20 to 25 per cent of dried gentian root. It has no value industrially; on the other hand, it is not a source of annoyance as are the other trisaccharides, raffinose and melezitose. It is also a nonreducing sugar, but since it contains the sucrose linkage, it is readily hydrolyzed by acids and invertase.

**Stachyose.** Stachyose, the sole member of the tetrasaccharide group, is another naturally occurring sugar of purely scientific interest. It has been found in the tuber of the Japanese artichoke, in the manna of the ash tree, and in the seeds of many legumes. *See also* STARCH; SUGAR BEET; SUGAR CANE. J. K. D.

**SUGAR MAPLE.** *See* MAPLE.

**SUICIDE,** the taking of one's own life. In the United States, suicide is numerically unimportant as a cause of death, accounting in 1944 for slightly less than one per cent of all deaths. The suicide rate in the United States has fluctuated with wars (decrease), prosperity (decrease), and depressions (increase) to an extent that makes it difficult to state a long-term trend, although indications are that it is slightly upward. During periods of peace and economic stability the rate tends to be about 14 or 15 per 100,000 of the population; during both World War I and II it decreased to about 10 per 100,000; during the prosperous 1920's it stood at 13 or 14; and during the depression of the 1930's it rose to 17.

In the United States, men commit suicide almost three times as frequently as women, but women make more unsuccessful suicide attempts than men. The rate for whites is approximately four times the rate for Negroes, while foreign-born whites have a higher rate than native-born. The rate increases with age. In 1944, the rate went from 0.4 per 100,000 for children from 10 to 14 years old to 27.2 for persons from 65 to 69 years old. Thereafter the rate decreased slightly. Cities have a higher rate than rural areas. Within a city, the suicide rates follow a characteristic pattern, being high in the disorganized areas near the central business district, such as slums, "homeless men" areas, and rooming-house areas, and increasingly lower toward the periphery of the city where family and community life is more stable.

**Europe.** Each nation has its own pattern of suicide. Ireland, with three suicides per 100,000, has one of the lowest rates of any civilized country. In the prewar period, the rate in Spain was about four, and in Italy about eight. Other nations with rates well below those for the United States are Canada, Norway, Netherlands, England, Wales, Australia, Bulgaria, Lithuania, New Zealand, Portugal, Romania, and Scotland. During the late 1930's, Austria had the highest rate, with about 39 suicides annually per 100,000 people. Other high-rate countries are Hungary, Germany, Czechoslovakia, Switzerland, Estonia, Denmark, and France. European countries having rates close to those for the United States are Belgium, Finland, and Sweden. Thus, the rates for various European nations prior to World War II varied from 3 to 38. These rates were not closely related to the racial classification of the population. The three nations with the lowest rates are Roman Catholic, whose church forbids the burial of a suicide in consecrated ground. The differences in rates are probably related, also, to internal social conditions and attitudes toward suicide as a method of meeting personal problems.

**Orient.** Japan, whose annual rate from 1875 to 1936 varied between 15 and 22 suicides per 100,000 population, differs from European countries in having both personal and institutionalized forms of suicide; that is, certain social situations demand that the person involved commit suicide regardless of his personal inclinations. India formerly had an institutionalized form of suicide, called suttee: the burning of a widow upon her husband's funeral pyre. This practice, though banned by the British in 1829, was continued in some sections of India until late in the nineteenth century.

**Suicide Among Primitive People.** In their native state, primitive peoples rarely commit suicide, probably because in the small, closely unified primitive community few personal problems arise. Some tribes have institutionalized suicides, such as those of widows and servants upon the death of a chieftain. The Eskimos encouraged suicide of the very old who had become a burden upon the community. R. S. C.

**SUIFU** or **IPIN** [swe'fu'; i'pi'n], formerly known as Suchow, a city in the southern part of Szechwan Province, China. It is situated 140 mi. southwest of Chungking at the junction of the Min River and the Kinsha-kiang (Golden Sand River), the latter being the name for the upper section of the Yangtze River. From Suifu down, the river is called the Yangtze. About 1,600 mi. from the mouth of the Yangtze, Suifu is the upper terminus for shipping from Ichang (Hupeh Province). Suifu is also the starting point for a projected 859-mi. railway to Kunming (Yünnan Province) along an ancient trade road which used to require a month to travel. The roadbed for the planned railway had been laid during World War II, but construction had never been accomplished, owing to the unstable political situation of China. Belonging to the Chienwei prefecture in the Han Dynasty (206 B.C.-A.D. 220), this city was named Nanchi in the Sung Dynasty (A.D. 960-1297) and Suchow in the Ch'ing (Manchu) Dynasty (A.D. 1644-1912). Ipin is the official name given to this city by the Chinese republican government. Located in the fertile Yangtze Valley, the Suifu region produces in abundance rice, sugar cane, tobacco, tangerines, oranges, and apples. Wine and tobacco manufacturing constitute essential industrial activities in the city. As an entrepôt for handling products destined for the lower Yangtze, Suifu thrives on trade in products from western Szechwan and Yünnan provinces, such as silk from Chengtu, insect wax from Loshan, salt from Tzeliutsing, and medicinal herbs from Yünnan Province. Pop. (est.), 150,000. A. C. T.

**SUITE** [swi't], a set of pieces, usually dance types, composed for one or more instruments and contrasted in tempo, meter, and mood. The practice of grouping two or more contrasting dance movements was well established in instrumental music by the sixteenth century. One of the basic groupings consisted of a stately, slow, and gliding floor dance in even meter, followed by a lively jumping dance in triple meter; thus a pavane would be followed by a galliard, and a passamezzo by a saltarello. The second dance was often a variant of the first, thematically speaking, and this sort of relationship between the suite movements was fairly common in the history of the suite even up to the time of J. S. Bach, in whose work it can be observed in the D-minor partita for solo violin. In lute books of the sixteenth century three such dances are frequently grouped together.

The fully developed suite, which culminated in the great Bach suites of the eighteenth century, was the composite product of the varied experiments with these groupings

that had occurred during the seventeenth century in France, Italy, Germany, and England. In France, these experiments took the form of lute, harpsichord, or clavichord pieces; in Italy, of chamber sonatas; in England, of vigorous, characteristically English suites by Henry Purcell and his contemporaries; in Germany, of diverse forms, among which are the earliest examples of the four-movement form later developed in the time of Bach.

Bach's numerous suites for keyboard and other solo instruments, for chamber groups, and for orchestra mark the peak of suite literature and are unexcelled in scope and expressiveness. Well before Bach's time the dance movements of the suite had become artistic idealizations of the actual dances that served as their prototypes, but in most of the movements of the Bach suite the rhythmic element is still important. With rare exceptions, these movements are all in the same key and the form of each is two-part, with the first modulating to a related key and the second returning to the tonic, often by a more circuitous route. The treatment generally involves a sort of loose interplay of motives, with a tendency toward ornate, rhapsodic freedom in the slower movements and a use of square meter in the faster movements.

The Bach suite consisted of four basic movements. The allemande, ordinarily a dance of moderate tempo in even meter, began with a short upbeat. The courante, which followed it, was a running dance in triple or duple-compound meter, or often both. The saraband was a slow, serious dance in triple meter, characteristically having a dotted quarter on the second beat. The gigue (from the Irish "jig"), which concluded the suite, was a lively dance in compound triple meter whose character was often taken over at a later date for the finales of sonata music. Bach went beyond this basic structure, however, and ordinarily inserted one or more additional movements, such as the bourrée, air, or loure, between the saraband and gigue.

After Bach the idea of the suite was carried over to a certain extent in the Classic *divertimenti,* and the term "suite" itself was still used from time to time, especially in the later nineteenth century, but gradually lost the fixed meaning indicated by the standard Baroque dance movements, for these were no longer composed. Typical of sundry uses of the term as indicating merely a loose grouping of separate pieces are Bizet's incidental music for *L'Arlésienne* (1872), Debussy's *Petite suite* for piano duet (1888), and Stravinsky's *Petrouchka suite* (1912).

W. S. N.

**SUIYÜAN** [swe′yüɑ′n], a Chinese province situated south of Outer Mongolia and flanked by Chahar on the east and Ningsia on the west. Its southern boundary touches Shansi and Shensi provinces. Suiyüan has an area of 134,181 sq. mi. Kweisui is the provincial capital.

**Topography and Climate.** The central part of the province is a highland formed by the western extension of the Yingshan range. Its highest peak, the Oongkung Shan (about 15,000 ft.), is north of Kweisui. The Hwang Ho (Yellow River) separates Suiyüan from Ningsia in the southwest, and before it enters Shansi, in the southeast, the river forms a huge bend in the shape of an inverted U, which is called Houtao, or the Hwang Ho Bend. The banks along the bend provide the richest farming region in the northwest. South of the bend is the Ordos Grassland, inhabited by Mongols. North of the bend is a contiguous part of the Mongolian highland. The climate in Suiyüan has sharp contrasts between summer and winter and between day and night. Winter is bitterly cold, especially north of the Yingshan range; the temperature drops to —26° F. In summer it rises to 100° F. Rainfall in central Suiyüan is about 13 in. a year.

**Economic Resources and Activities.** Agricultural activity in the Hwang Ho Bend area is limited by the need for irrigation. The adjacent silt land is irrigated by a system of fourteen main canals watering a total of 198,000 acres. The principal crops are barley, oats, millet, kaoliang, and hemp, more than sufficient for the farming population. The chief resources available for export are coal, alkali, salt, livestock, wool, and furs.

The only railroad in Suiyüan is the Peiping-Suiyüan Railway, which connects Paotow, the leading trade center in central Suiyüan, with Peiping in Hopeh Province. Imperial roads and caravan routes still play an important role in Suiyüan's communications, and the camel continues to be the best means of transportation over the grassland and deserts.

**Population and Cities.** The inhabitants of Suiyüan are largely Chinese, and the Mongols are the largest minority group. The Mongols are divided into two leagues, the Ulanchab and the Ikhachao, each of which is subdivided into several smaller political divisions, or banners. The Mongols are mostly nomadic and wander from place to place with their livestock wherever pasture is available. The dialect is Western Mongolian.

Kweisui, the capital city on the Peiping-Suiyüan Railway, is the converging point of the road network to Kansu, Sinkiang, Ningsia, and Tsinghai, making it one of the most important towns in northwestern China. Paotow, at the western terminus of the railroad, is a mining and wool-producing center; and Pailingmiao, in northern Suiyüan, is a prosperous town on the Sinkiang-Suiyüan camel caravan route.

**History.** Suiyüan became an integral part of China during the Han Dynasty (206 B.C.-A.D. 220). The whole territory was then divided into four states: Tinghsiang, Yunchung, Sofang, and Wuyuan. At the beginning of the thirteenth century, when the Mongols gained power, this region was known as Tatung Route. During the Manchu Dynasty, Suiyüan became a part of Inner Mongolia, together with Chahar and Jehol, and in 1928 it was declared an independent province. The growth of the Mongolian autonomous movement brought into existence the Mongolian Autonomous Political Council, established at Polingmiao in 1934, to direct Mongol activities in Chahar and Suiyüan under Mongol princes. A reorganization took place in 1936 and Chahar and Suiyüan provinces each received separate councils. Pop. 1947, 2,084,000.

A. C. T.

**SUK.** *See* African Peoples.

**SUKKOTH** [sukо′th], or Feast of Tabernacles, a Jewish festival lasting for nine days, beginning on the fifteenth day of the Hebrew month Tishri, which occurs in the early autumn. The first two days and the last two days are full holidays; on the five intermediate days, called *hol ha-moed,* work is permitted.

Marking the season of the fruit harvest and thus the end of the agricultural year, Sukkoth, also referred to as *hag ha-asif* ("Feast of the Ingathering"), was the principal Hebrew agricultural festival of Biblical times. Since the destruction of the Temple (A.D. 70), Sukkoth has been celebrated by the inclusion of special liturgy in the synagogue services, by processions in the synagogue with the *lulab* and *ethrog,* and by eating in a *sukkah* especially built in the honor of the festival. The *sukkah* is a simple structure with a thatched roof, suffi-

ciently open to permit the sky to be seen, and customarily decorated with fruits of the season. The *sukkah* may probably be traced to the ancient practice of living in the field during the harvest, but it is traditionally commemorative of the temporary dwellings of the Hebrews in the wilderness. In both the ancient and modern observance of Sukkoth the motif of thanksgiving has been stressed.

The last three days of Sukkoth have individual names and characteristics. The seventh day is called Hoshanah Rabbah; the eighth day, Shemini Atzereth; and the ninth day, Simchath Torah. On the latter day the annual reading of the Pentateuch or Torah (which is divided into weekly portions) is completed and begun anew. In Palestine, the features of Shemini Atzereth and Simchath Torah are combined on the eighth day, which is there celebrated as the last of the festival. *See also* ETHROG; LULAB. D. G. and G. W.

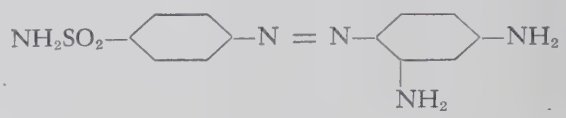
**SUKKUR** [sʊ′kkʊr], the chief city of the Sukkur District in northeastern Sind Province, in western Pakistan, about 240 mi. northeast of Karachi, in a hot desert region where the average rainfall is between 1 and 10 in. annually. An important commercial center, the city is located near a gorge on the west bank of the Indus River, famous as the site of the great Lloyd or Sukkur Dam, one of the largest irrigation dams in the world. Completed in 1932, it irrigates about 7,500,000 acres of fertile alluvial soil along the Indus, where wheat and millet are grown. The city has cotton ginning, silk milling, dyeing, rice and flour milling, and other industries. Pop. 1952, 77,057.

**SULAIMAN MOUNTAINS** [sʊlimɑ′n], a range located in central Pakistan, extending southward from the Pamir Knot and Hindu Kush Range. The average elevation is about 5,000 ft., but there are many higher peaks, some of more than 11,000 ft., on the border of northeastern Baluchistan. Twin peaks known as Takht-i-Sulaiman, meaning "throne of Solomon," reach 11,100 ft. in height. J. E. F.

**SULEIMAN I** [sülemɑ′n] (c.1496-1566), called the Magnificent, sultan of the Turkish Empire, was born in Constantinople about 1496, the son of Selim I. A cultured man, he encouraged learning and the arts. He is generally considered the greatest of the sultans, under whom the Ottoman Empire reached its height. The improved system of government during his reign was actually the work of his viziers, especially the famous Ibrahim Pasha who was in control from 1523 to 1536. When Suleiman succeeded his father as sultan in 1520 he set out on a career of conquest. In 1521 he captured Belgrade, after invading Hungary to force the payment of tribute which had been withheld. Five years later the Hungarian king, Louis II, was killed and his army completely defeated at the battle of Mohács. In 1529 Suleiman laid siege to Vienna but was forced to withdraw. In the meantime his fleets had taken the island of Rhodes from the Knights of St. John in 1522, and had gone on to conquer Tripoli and Algiers in North Africa. Beginning in 1533 a series of wars against Persia won Mosul, Tabriz, Baghdad, and much other territory for the Ottoman Empire. In 1536 the sultan made a formal alliance with Francis I of France against the Hapsburgs, and gave France sole Occidental participation in the commerce of the Levant. He failed to take Malta from the Knights of St. John in 1565, and on Sept. 5, 1566, he died during the siege of Szigetvár in Hungary. F. C. H.

**SULFONAMIDES** [sʌlfonæ′midz], a group of chemical compounds used in the treatment of bacterial diseases. The development of the sulfonamides was perhaps the greatest single advance in medicine in the twentieth century. In their wake have come the antibiotics, including penicillin, tyrothricin, streptomycin, polymyxin, chloromycetin, aureomycin, and terramycin, which, however, did not entirely displace the sulfonamides.

Fritz Mietzsch and Joseph Klarer, chemists, and Gerhard Domagk, a pharmacologist in the laboratories of the I. G. Farbenindustrie in Wuppertal-Elberfeld, Germany, are credited with the synthesis of the sulfonamides in 1931. The initial product, effective in experimental animals, specifically mice, was prontosil, a coloring matter or dye:



The compound was shown to be broken down in the body to

sulfanilamide—para-aminobenzenesulfonamide, which is not a dye.

From this basic formula have been derived thousands of compounds with varying action in the test tube, and in mice and other animals, against bacterial infections. The following derivatives are of greatest importance, have had the widest use, and have been shown to be most effective in non-toxic dosage: sulfathiazole, sulfapyridine, sulfadiazine, sulfamerazine, sulfamethazine (now known as sulfamezathine), sulfaquinoxaline, and sulfaguanidine.

They interfere with the utilization of PABA (para-aminobenzoic acid), an essential metabolite for the growth of most bacteria. The effect of the sulfonamide can be overcome by increasing the concentration of PABA in growth medium. Sulfonamides have greatest use in treating septicemias (blood poisoning) and general infections. The sulfonamide is absorbed and establishes itself in the blood stream where it exerts its effect against bacteria in the blood, as well as in tissues fed by blood.

Sulfonamides are excreted by the kidneys and, to a limited extent, by other excretory and secretory tissues.

Sulfonamides are primarily bacteriostatic, rather than bactericidal. They interfere with bacterial respiration, growth, and reproduction, and permit active phagocytosis, or destruction of bacteria by white blood cells. They have greatest effect against rapidly growing bacteria and therefore produce most dramatic results in the treatment of acute bacterial diseases. In many species, the effect of the sulfonamide is in direct ratio to its concentration.

For the most part, sulfonamides are insoluble in water at neutral pH, and, depending on the compound, have greater solubility when the solution is made acid or alkaline. Most sulfonamides used in solution today are sodium salts prepared by adding caustic soda—NaOH—to suspensions of the compound.

Not all bacteria are susceptible to sulfonamides. They are regularly used for the treatment of bacterial diseases, in man and animals, that are caused by streptococci, staphylococci, many gram-negative and gram-positive bacteria, and protozoa such as coccidia. C. R. S.

**SULFUR.** *See* SULPHUR.

**SULLA, LUCIUS CORNELIUS** [sʌ′lə] (138-78 B.C.), Roman statesman and general. Sulla first won his spurs

in Africa, where he served during 107-106 B.C. as quaestor in the army of Marius and brought about the capture of King Jugurtha of Numidia. In 92 B.C., as propraetor in the eastern Mediterranean, he was instrumental in halting the first advances of Mithridates of Pontus toward the Aegean. In the Social War of 90-88 B.C. Sulla was the most successful of the Roman generals, a fact which brought him to the consulship in 88 B.C. In renewed operations against Mithridates in Greece and Asia Minor shortly thereafter, Sulla again demonstrated his military genius by driving Mithridates from Greece and ultimately forcing him to sign a peace treaty wholly favorable to Rome. While Sulla was absent from Italy the Marian (popular) party gained control of Roman politics, and his return to the peninsula in 83 B.C. touched off a bitter civil war in which Sulla and his senatorial partisans overwhelmed the popular party. Sulla then consolidated the conservative victory by wholesale executions and confiscations, which broke the power of the Marians for many years. Between 82 and 79 B.C. Sulla held the position of dictator, an office which had formerly been limited to a term of six months. As supreme head of the state, he secured the passage of reactionary legislation which practically barred the equestrian class from any real participation in the government, while direction of the affairs of state became almost a monopoly of the senatorial group. Broken in health, Sulla at last resigned his dictatorship and died in retirement in 78 B.C. T. B. J.

**SULLIVAN, SIR ARTHUR SEYMOUR** (1842-1900), English composer, was born in London on May 13, 1842, of Irish parentage. His father was a musician. Sullivan's musical career began in 1854, when he became a Chapel Royal choir boy. He continued his musical education as a scholarship student at the Royal Academy of Music (1856) and the Leipzig Conservatory (1858). His first published composition was an anthem issued in 1855, but he had his first success as a composer in 1862 with his incidental music to Shakespeare's *The Tempest.* Between 1855 and 1875 the composer added to his musical experience by serving as organist choirmaster, and conductor in Glasgow, and at St. Michael's, Chester Square, in London (1861-1872), and by visiting Vienna to assist in the recovery of lost Schubert manuscripts.

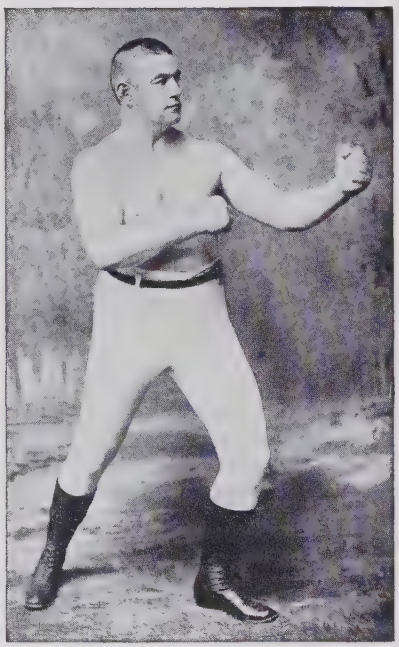
*SIR ARTHUR SEYMOUR SULLIVAN*

BROWN BROTHERS

From 1875 to 1896 the London stage saw the production of thirteen comic operas by Sullivan, with librettos by W. S. Gilbert. The sprightly cleverness of Gilbert's lyrics, together with Sullivan's flair for the theatre and his mastery in setting the English language to music, brought into existence a repertoire of stage works unequalled in their field. The most enduring of these, with the dates of their first performances, are *Trial by Jury* (Mar. 25, 1875), *H. M. S. Pinafore* (May 25, 1878), *The Pirates of Penzance* (Dec. 31, 1879), Patience (Apr. 23, 1881), *Iolanthe* (Nov. 25, 1882), *The Mikado* (Mar. 14, 1885), *Ruddigore* (Jan. 22, 1887), *The Yeomen of the Guard* (Oct. 3, 1888), and *The Gondoliers* (Dec. 7, 1889).

Sullivan's creative output was large and varied. In addition to the comic operas he wrote a grand opera, *Ivanhoe,* several concert overtures, an "Irish" symphony, several cantatas and oratorios, many hymns, among them *Onward, Christian Soldiers,* and some very successful songs, both secular and sacred, including *The Lost Chord.* Yet it is in the operettas that the bulk of his output lies and on them that his fame rests. In 1883 Sullivan was knighted by Queen Victoria in recognition of his contribution to the world of music. After his first successes Sullivan lived the life of a Victorian gentleman of means and culture. He knew most of the great European musicans of his time and was a friend of members of the royal families of England and France. He died in London Nov. 22, 1900. *See also* SAVOY OPERAS. L. Bu.

**SULLIVAN, JOHN LAWRENCE** (1858-1918), American pugilist, was born in Roxbury, Mass., Oct. 15, 1858. He attended local public schools, studied for a short time at Boston College, and then worked as a plumber, tinsmith, and professional baseball player. In 1878 he began a career as a boxer and won the world's heavyweight championship under London Prize Ring rules (bare knuckles) in 1882. Thereafter he was never defeated in a bare-knuckle fight and was the last of the champions in this form of boxing. Under the management of Billy Madden he made many exhibition tours, boxing by Marquis of Queensberry rules. He offered a prize of $100 (later $500) to any man who could stay four rounds with him, and although no one accomplished this feat the exhibitions helped to popularize boxing in the United States. Sullivan's last fight in defense



*JOHN L. SULLIVAN*

BROWN BROTHERS

of his bare-knuckle title was in 1889 in Richburg, Mass., where he won from Jake Kilrain in 75 rounds.

The first battle for the heavyweight championship of the world under Marquis of Queensberry rules was fought by Sullivan and James J. Corbett in 1892 in New Orleans. Sullivan's bare-knuckle title was not at stake, but Corbett, by winning by a knockout in 21 rounds, became the first Queensberry champion. Sullivan appeared in the ring only once after that, in an exhibition bout with Tom Sharkey in 1896. He fought a total of 37 matches, winning 12 by knockouts and 20 on decisions. Three matches ended in draws, one with no decision, and he was knocked out only once. He died in Abington, Mass., Feb. 2, 1918. C. W. D.

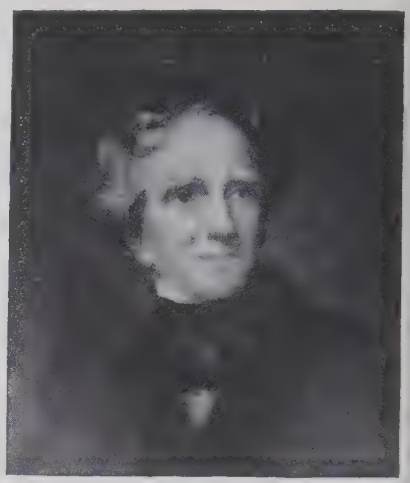
**SULLIVAN, LOUIS HENRI** (1856-1924), American architect, was born in Boston, Mass., Sept. 3, 1856, of Irish and Swiss-French parentage. He attended the Massachusetts Institute of Technology and the Ecole des Beaux Arts, Paris. He began his architectural practice at Chicago in 1880, forming a partnership there with Dankmar Adler in 1881. This partnership lasted until Adler's death in 1900, after which Sullivan practiced alone. From the beginning, Sullivan cut loose from tradition and outworn convention. He was a pioneer in modern architecture, particularly as illustrated in the skyscraper. He gave close study to problems of acoustics and skeletal construction but was even more concerned with abstract form. In addition to the structural excellence of his buildings, their exteriors evidence creative fertility of design.

Sullivan's Wainwright Building, St. Louis, built in 1890 of terra cotta and glass hung on an iron skeleton, was an early skyscraper. In its masterful relating of form to function without too severe a functionalism, it served as a criterion for later tall buildings throughout the United States. Other notable buildings by Sullivan were the Chicago Auditorium, 1889, influenced by H. H. Richardson; Pueblo, Colo., Opera House, 1890; Wainwright Tomb, St. Louis, 1892; Transportation Building, World's Columbian Exposition, Chicago, 1893; Chicago Stock Exchange Building, 1894; Prudential Building, Buffalo, 1895; Bayard Building, New York, 1898; Schlesinger & Mayer Department Store (later Carson Pirie Scott), Chicago, completed in 1904; Henry Babson estate, Riverside, Ill., 1907; and National Farmers Bank, Owatonna, Minn., 1908.

From 1886 to 1923, Sullivan made vigorous contributions in writing and in lectures to the arts, education, and democracy. His most noteworthy and popular book, *The Autobiography of an Idea* (1924), is an account of his life and of the dominant inner spirit that controlled it. Of his many essays, *What Is Architecture?* is of special importance. Sullivan died in Chicago on Apr. 14, 1924. G. G. E.

**SULLIVAN,** a city in southwestern Indiana, the county seat of Sullivan Co., situated 27 mi. south of Terre Haute. Sullivan was founded in 1842 and incorporated in 1909. A mayor and city council administers the city government. The Illinois Central and the Chicago & Eastern Illinois railroads provide transportation. The surrounding region has coal fields and oil wells, and Sullivan is a shipping market for these natural resources and for the grain grown in the district. Machine shops, hatcheries, and a cheese factory are located in the city. Pop. 1950, 5,423.

**SULLY, THOMAS** [sʌ'li] (1783-1872), American painter, was born in June 1783, at Horncastle, Lincolnshire, England. Brought to America in 1792, Sully grew up in Charleston, S. C., but he made his home in Philadelphia after 1808. The years 1809 and 1810 he spent as a student with Benjamin West in London. Sully's graceful style made him one of the most popular portrait painters of his day, particularly in the second quarter of the century. Among his most celebrated sitters were LaFayette, Queen Victoria, and the actress Fanny Kemble, as well as many outstanding American political figures, including three presidents, Jefferson, Madison, and Jackson. Sully was also an accomplished miniaturist. He died in Philadelphia, Nov. 5, 1872. E. B. S.



*THOMAS SULLY*

FROM A SELF PORTRAIT

COURTESY OF THE HISTORICAL SOCIETY OF PENNSYLVANIA

**SULLY PRUDHOMME** [sü'li' prü'dɔ'm], pseudonym of René François Armand Prudhomme (1839-1907), French poet, was born Mar. 16, 1839, in Paris. He studied the sciences and became a civil engineer, but, growing discontented in this career, he became a clerk in a notary's office, seeking leisure to write poetry. At first, he wrote sentimental verse in which he analyzed his melancholy. The *Stances et poèmes* (1865) ("Stanzas and Poems") contained some poems such as *Vase brisé* ("The Broken Vase"), which were to appear in many school textbooks. They were written in a sentimental strain and in an elegant and correct style, characteristics which appeared in his later books, *Les Epreuves* (1866), *Les Solitudes* (1869), *Les vaines tendresses* (1875).

In 1869, Sully Prudhomme translated the first book of Lucretius and, in a preface, expressed his interest in philosophical and scientific poetry. However, he preached in his poetry that the way to happiness lies through the practice of brotherly love and virtue. Most of his compositions are mere developments of commonplaces on justice, happiness, and virtue. But he wrote also a long poem, half lyrical, half didactic, on life after death, and in 1876 he published, in the *Revue des deux mondes,* a poem in memory of three balloonists who had met death in their heroic endeavor to reach the stratosphere. After 1888 he devoted himself to philosophy, and he was an early and ardent Dreyfusard. He died in Paris, Sept. 7, 1907.

He was elected to the Académie Française in 1881 and received the Nobel Prize in 1901. After his death his poetry came to be considered cold and prosaic, and his reputation sharply declined. R. Ta.

**SULMONA** [sulmo'nɑ], a communications center in the province of L'Aquila, Abruzzi e Molise, in central Italy. It is situated at the southeast corner of an intermountain basin (the verdant Conca Peligna) on the Gizio River, an affluent of the Pescara, at 1,320 ft. above sea level, about 75 mi. east of Rome. It is surrounded on all sides by moun-

tains, including La Maiella to the east. A small industrial center, Sulmona owes its importance primarily to its position on the principal historic route from Rome to the Adriatic on the Via Valeria where it crosses another highway, paralelling the Apennines, from Aquila to Benevento and Naples. These ancient routes are followed by railways.

The town, strung out between the Gizio and Vella rivers, contains several interesting monuments, including the Cathedral of San Ponfilo; the Church of San Francesco della Scarpa, erected in the thirteenth century by Charles of Anjou but later reconstructed after an earthquake, a phenomenon to which the region is frequently subject; the Church and Palace of Santa Maria Annunziata, begun in 1415 but containing elements of both Renaissance and Gothic detail; and a statue of Ovid, a native of the city.

Sulmona was a city of some consequence in pre-Roman and Roman times, when it was known as Sulmo. After a period of obscurity, it reached its greatest glory under the Hohenstaufens and Angevins in the thirteenth and fourteenth centuries. In 1294 the hermit-pope Celestine V was crowned in its cathedral. Pop. (off. est. 1947), 23,729, including suburbs. R. G. W.

**SULPHUR** [sʌ'lfər], symbol S, atomic number 16, at. wt. 32.066. Monoclinic sulphur density is 1.957, m.p. 119.0°C., b.p. 444.6°C.; rhombic sulphur density is 2.07, m.p. 112.8°C., b.p. 444.6°C. Sulphur, called the same in Latin, is the second element in Group VI-B in the periodic table. It follows oxygen and, in turn, is followed by selenium, tellurium, and polonium. Its atom has two completed shells of electrons (2,8) and an outer shell containing 6 electrons. Sulphur does not give up its electrons to other elements, hence it is nonmetallic in nature. Since it readily shares its electrons with other nonmetals, it sometimes has a positive valence. One of the outstanding distinctions of sulphur is its ability to form oxides ($SO_2$ and $SO_3$) by sharing electrons (co-ordinate covalence) and acquiring valences of +4 and +6. These oxides are stable, and their derivatives are among the most important compounds that the chemist knows. This behavior is all the more remarkable because, as a rule, elements near each other in the periodic table do not combine readily.

**Occurrence.** Sulphur is found in a few localities in the uncombined state, and from these a large proportion of the commercial sulphur is obtained. In addition there are vast supplies of sulphide ores of the metals, such as lead, zinc, copper, and iron (pyrites). In winning these metals from their ores they are usually freed from sulphur by heating in the presence of oxygen. Under these conditions sulphur dioxide is formed, which frequently is allowed to go to waste. In addition to the sulphide ores, sulphur is extensively found in sulphates such as calcium sulphate (gypsum) or barium sulphate (heavy spar). Soluble sulphates such as those of magnesium and sodium are present in ocean water and many mineral waters. Hydrogen sulphide is present also in some mineral waters, forming "sulphur waters."

Commercial sulphur may be obtained from smelter, coke-oven, refinery, fuel, or natural gases. Sulphur from native underground deposits is melted by high-pressure steam and brought to the surface by compressed air and pumps; by the Frasch process, an ingenious system of concentric pipes, sulphur of 99.5 per cent purity is obtained.

Texas and Louisiana supply most of the elementary sulphur used in the United States. Spain, Italy, Japan, Chile, Russia, Norway, and Sweden produce quantities of sulphur and pyrites.

**Forms.** In its familiar forms, sulphur is either a yellow granular powder or a brittle crystalline mass, without odor or taste, insoluble in water. Sulphur can be prepared in various allotropic forms, which differ materially in color, solubility, and chemical behavior.

*Crystalline.* There are two crystalline forms. The first of these, rhombic sulphur, is best prepared by allowing its solution in carbon disulphide to evaporate at room temperature. The crystals are diamond-shaped, light-yellow in color, translucent, and readily soluble in carbon disulphide. This is the stable form of sulphur below 96° C., to which the other allotropic forms tend to change on standing. When molten sulphur is allowed to cool in cylindrical molds, it forms rhombic sulphur with large crystals distorted by crowding. This is the material called brimstone in commerce. The second crystalline form, monoclinic sulphur, stable above 96° C., forms long needlelike crystals, transparent, and soluble in carbon disulphide. On standing, these crystals revert to the yellow rhombic form.

*Noncrystalline.* Solid sulphur exists also in two noncrystalline forms. The first, colloidal sulphur, or milk of sulphur, is prepared by precipitating sulphur from solution, for example by boiling sulphur with lime, filtering, and adding hydrochloric acid to the clear filtrate. The precipitated sulphur is very finely divided, white, and completely soluble in carbon disulphide. This form is used in medicine as a laxative, antiseptic, and antiparasitic in dusting powders and ointments. The other solid form, amorphous or plastic sulphur, is formed by sudden cooling of the molten material as by pouring into cold water. It is dark-red or brown in color, rubberlike, specific gravity 2.046, and insoluble in carbon disulphide. On standing, it becomes brittle, yellow, and partly soluble in carbon disulphide as it reverts to the rhombic form. In addition to these crystalline and amorphous forms, there is an intermediate form, known commercially as flowers of sulphur or sublimed sulphur, produced by chilling sulphur vapor without passing through the liquid phase. It is composed of small grains with a crystalline center and amorphous surface. It is slowly and incompletely soluble in carbon disulphide. When treated with ammonia, to remove such impurities as arsenic, the product is known in medical circles as washed sulphur, the uses of which are similar to those of the colloidal form.

**Uses and Principal Compounds.** Nearly half of the sulphur consumed is used in making important chemical compounds like sulphuric acid, sulphur dioxide, and carbon disulphide. Other important uses are in insecticides, fertilizers, and explosives; the manufacture of paper, plastics, paint, and dyes; and the vulcanizing of rubber.

*Sulphur Dioxide.* The compounds of sulphur are many and important. There are two important oxides, the dioxide, $SO_2$, and the trioxide, $SO_3$. The dioxide is produced by burning sulphur in air; and vast quantities of it result from the roasting of sulphide ores of the metals. Sulphur dioxide, a colorless gas with a suffocating odor, is readily soluble in water, forming sulphurous acid. It is easily liquefied (boiling point —10° C.) and is sold in steel cylinders. It is used in the manufacture of sulphuric acid; in household refrigerating units; in bleaching, as in textiles, straw, wood pulp, beet sugar, in preserving fruits and vegetables; and in disinfecting, as in breweries, food-processing plants, starch factories.

*Sulphurous Acid.* Sulphurous acid, $H_2SO_3$, is a clear, colorless liquid that contains about 6 per cent sulphur dioxide. It is a weak acid (ionization constant $5 \times 10^{-6}$, giving $2H^+$), forming both sulphites and acid sulphites. It is a good reduc-

ing agent, uniting with oxygen to give sulphuric acid. It is used for removing the coloring matter from silk, wool, straw, paper, and similar materials. It is used also as an antiseptic and preservative, especially for preventing the growth of fungus in wine casks and preventing fermentation when corn is being softened for the extraction of starch. It is also used in preserving foods to prevent blackening and fermentation. The most important salt of sulphurous acid is calcium acid sulphite, $Ca(HSO_3)_2$, used for the digestion of wood chips in the preparation of wood pulp.

*Sulphur Trioxide.* Sulphur trioxide, $SO_3$, the anhydride of sulphuric acid, is obtained either as a colorless liquid or as a white crystalline solid. It is formed by oxidation of sulphur dioxide by means of oxygen in the presence of a suitable catalyst (platinum, vanadium pentoxide). It fumes strongly in moist air and dissolves in water, forming sulphuric acid and liberating a large amount of heat. It is used in making sulphuric acid and in the production of synthetic organic compounds.

*Sulphuric Acid.* Sulphuric acid, $H_2SO_4$, is made by steps which appear to be relatively simple but actually are highly involved. Sulphur is oxidized to sulphur dioxide by burning in air or by roasting sulphide ores. This product is further oxidized to sulphur trioxide either by the use of a catalyst (contact process) or by the use of the oxides of nitrogen (lead-chamber process). The refined acid is a heavy, colorless liquid called oil of vitriol, which fumes in moist air and absorbs water vigorously, even decomposing many carbohydrates like sugar ($C_{12}H_{22}O_{11}$) which contain hydrogen and oxygen in the same proportion as they are found in water. Sulphuric acid is highly corrosive and produces severe burns upon the skin. It is readily dissociated by heat, yielding sulphur trioxide and water. It reacts with many of the metals and metallic compounds. Because it is an active acid and not expensive, its uses are very numerous.

Fuming sulphuric acid is the concentrate acid to which an excess of sulphur trioxide has been added. It is a colorless, or brownish, oily liquid, known commercially as oleum; it gives off offensive fumes of sulphur trioxide and is an extremely active chemical reagent.

*Thiosulphuric Acid.* Thiosulphuric acid, $H_2S_2O_3$, is sulphuric acid in which one atom of oxygen has been replaced by sulphur. Its most important derivative is sodium thiosulphate, $Na_2S_2O_3 \cdot 5H_2O$, colorless crystals formed when sodium sulphite, $Na_2SO_3$, is boiled with flowers of sulphur. It is used in photography as a fixing agent and is known as the hyposulphite of sodium or simply as hypo. It is also used in the bleaching industry as an antichlor to arrest the action of chlorine before the fibers are weakened by too long exposure to chlorine; in dyeing and printing textiles; in extracting silver from its ores; in tanning leather; and in bleaching bone, straw, and ivory.

*Other Oxyacids.* There are many other oxyacids of sulphur, more or less closely related to sulphurous or sulphuric acids. Perhaps the most interesting of these is sulphamic acid, $HSO_3 \cdot NH_2$. It should be regarded as sulphurous acid, with one of its hydrogens replaced by the amino group, $NH_2$. Sulphamic acid is prepared by the action of oleum on urea, $NH_2 \cdot CO \cdot NH_2$. This strong acid forms colorless crystals, stable in dry air, soluble in water, and hydrolyzed in solution. Its most useful compound is ammonium sulphamate, a white crystalline powder readily soluble in water. It is useful in making textiles, paper, and wood fire-resistant. As a weed killer, it is particularly effective against poison ivy.

*Sulphonal.* Sulphonal, $(CH_3)_2 \cdot C \cdot (SO_2 \cdot C_2H_5)_2$, is a white, odorless crystalline drug, slightly soluble, used as a sedative and hypnotic in cases of insomnia, alcoholism, nervous afflictions, and insanity.

*Hydrogen Sulphide.* Hydrogen sulphide, $H_2S$, called also sulphuretted hydrogen and hydrosulphuric acid, is a colorless gas with an offensive odor suggestive of rotten eggs. It is a little heavier than air (sp. gr. 1.189), easily condensed to a colorless liquid (b.p. —61.8°C.), and readily soluble in water. The liquid is a useful solvent. The solution, or the gas, itself, is used extensively in qualitative analysis in the detection and separation of many of the metals. When inhaled in a small amount, the gas produces headache and nausea; a larger amount or continued inhalation produces paralysis, especially of the nerves, heart, and lungs. The paralysis gives no warning of its approach, and serious injuries may result from a fall caused by the suspension of vital body functions. The water solution of the gas is a weak acid, with a *p*H of approximately 4; the apparent ionization constant, giving $2H^+$, is $1.2 \times 10^{-15}$. The formula of hydrogen sulphide suggests a close relationship to water; but perhaps nothing shows more clearly the contrasts between sulphur and oxygen than a comparison between $H_2S$ and $H_2O$. In hydrogen sulphide, sulphur acts as a typical nonmetal, the valence of sulphur in this compound being —2; but the behavior of these two compounds shows almost no other point of similarity, and their contrasts are striking.

*Sulphur Monochloride.* Sulphur monochloride, $S_2Cl_2$, is a fuming, oily liquid with an amber color and penetrating odor, causing tears and labored breathing. It fumes in moist air and is decomposed by water, but is soluble in carbon disulphide. Sulphur monochloride is a good solvent for sulphur, iodine, metallic halides, and organic compounds. It is used in vulcanizing rubber, and in making printing inks and insecticides. When it reacts with ethylene, sulphur monochloride produces a volatile liquid known as mustard gas, $(C_2H_4)_2Cl_2S$, a highly irritating and toxic substance used in chemical warfare.

*Carbon Disulphide.* Carbon disulphide, $CS_2$, is a faintly yellow liquid, highly inflammable and poisonous. It is made by the direct union of the elements in an electric furnace. It does not mix with water and has a high index of refraction, high vapor tension, and low boiling point, 46° C. It is an effective solvent for fats, oils, rubber, and resins. It is widely used in the extraction of oils, in the manufacture of viscose rayon, varnishes, rubber cements, and matches, for destroying weevils and clothing moths, and for disinfecting soils. *See also* SULPHURIC ACID. B. S. H.

**SULPHUR FLOWER,** a white wooly perennial, *Eriogonum umbellatum,* of the buckwheat family, having a branching, woody base surrounded by many small leaves. Several long-stalked umbels of brilliant, drooping flowers, sulphur-yellow in color, are borne at the summit of the naked flower stalks, which are 4 to 12 in. high. The plant is native to dry elevated valleys and mountains from California and Washington to Colorado and Wyoming; it grows usually at an altitude of 4,000 to 9,000 ft. J. C. Wis.

**SULPHURIC ACID** [sʌlfyu'rɪk], the mineral acid $H_2SO_4$, is generally classed as the most important of the acids. It appears to have been known as far back as the ninth century. In the thirteenth century, sulphuric acid was referred to by Albertus Magnus as spirit of vitriol. It has likewise been termed oil of vitriol and vitriolic acid because of its appearances and its derivation from green vitriol (ferrous sulphate). Although its preparation was described as early as the fifteenth century, the exact composition of

sulphuric acid was not known until the time of the French scientist Antoine Laurent Lavoisier (1743-1794). The salts of sulphuric acid are widespread over the earth's surface; for example, gypsum (the dihydrate of calcium sulphate), and the many brine deposits containing sulphates of the alkaline and alkaline-earth metals. Sulphuric acid, itself, may be found in the vicinity of volcanoes, where it results from the oxidation in moist air of the sulphurous gases emitted.

Time has contributed much to the technology of the manufacture of sulphuric acid. The equipment designed for its production introduced new concepts and principles, which have since been applied in other similar manufacturing processes.

## LEAD-CHAMBER PROCESS

The oldest method of manufacturing sulphuric acid is the lead-chamber process, introduced in 1746 at Birmingham, England. Although this process owes its name to the characteristic large reaction chambers made of sheet lead, the entire modern plant usually consists of sulphur dioxide-producing burners, a niter pot or ammonia oxidation unit, a Glover tower (introduced in 1858), the chambers proper, and the Gay-Lussac tower (introduced in 1830). The over-all reaction, which consists in oxidizing sulphurous gas to sulphuric acid, is promoted by nitrogen oxides formed either by the action of process acid on Chile saltpeter or by the oxidation of ammonia. These reactions yield the nitric oxides, NO and $NO_2$. By a series of intermediate reactions not yet fully understood, the nitric oxides react with sulphur dioxide and air in the presence of moisture to form nitrosyl sulphuric acid according to the following reaction:

$$\underset{\text{Sulphur dioxide}}{2SO_2} + \underset{\text{Oxygen}}{O_2} + \underset{\text{Nitric oxide}}{NO} + \underset{\text{Nitrogen dioxide}}{NO_2} + \underset{\text{Water}}{H_2O} = \underset{\text{Nitrosyl sulphuric acid}}{2NO \cdot HSO_4}.$$

In the presence of excess water, the nitrosyl sulphuric acid decomposes to sulphuric acid and nitrogen trioxide:

$$\underset{\text{Nitrosyl sulphuric acid}}{2NO \cdot HSO_4} + \underset{\text{Water}}{H_2O} = \underset{\text{Sulphuric acid}}{2H_2SO_4} + \underset{\text{Nitric oxide}}{NO} + \underset{\text{Nitrogen dioxide}}{NO_2}.$$

**Sulphur Burners.** The first step in the production of sulphuric acid is the manufacture of sulphur dioxide. One important source of sulphur for this process is a yellow ore, consisting essentially of the sulphide of iron, and known as fool's gold or, more commonly, pyrite. Pyrite burns in air to form sulphur dioxide and iron oxide, which may be used as iron ore. The pyrites may be burned in lump form in ordinary furnaces, or as fines. Fines are spread over a series of plates in a multiple-hearth furnace, which may be either stationary or equipped with rotary scrappers. Once combustion has been initiated by a coke fire, for example, the pyrites themselves will support combustion in the presence of a positive air flow over the plates. Very finely divided pyrites are burned in powder form by injection with air into a flash burner. Sulphides of copper and zinc (blende) also are sources of sulphur. For this reason, sulphuric-acid plants are sometimes located near smelters, which use the sulphurous gases discharged by the pyrite and blende roasters. The third important source of sulphur in the production of sulphuric acid is brimstone sulphur. Sulphur may be burned in the tray-type furnaces, but a more satisfactory method consists of spraying molten sulphur with air into a special burner.

**Nitrogen Oxides Unit.** The sulphur dioxide gases pass from the burners to the source of nitrogen oxides. Where these are formed by the action of process acid on Chile saltpeter, the gases pass over the niter pot, yielding heat, which promotes the reaction forming nitric acid. When oxidation of ammonia is used to produce the nitrogen oxides, the gases pass separately to the Glover tower.

**Glover Tower.** A Glover tower is essentially a tall structure lined with sheet lead and acidproof brick. It is filled with quartz of assorted sizes in such a way that spaces are left at the bottom and the top of the tower for distribution and drawoff of gases and acids. The burner gases enter at the bottom of the tower and rise through the stream of Gay-Lussac and chamber acid which is sprayed over the quartz filling by means of a suitable distributor at the top of the tower. This simple design fulfills four important functions: (1) it cools the sulphurous gases from the burners prior to their entrance into the lead chambers; (2) it utilizes the heat absorbed to concentrate chamber acid; (3) it recovers the nitrogen oxides released from the Gay-Lussac acid by the dilute chamber acid; (4) it supports the preliminary reaction between the steam, nitrogen oxides, and sulphur dioxide in the formation of the sulphuric acid. Glover acid issuing from the bottom of the tower is further cooled and pumped to the top of the Gay-Lussac tower for recovery of nitrogen oxides by absorption.

**Lead Chambers.** The initial reaction products, on the other hand, pass from the top of the tower to a series of rectangular lead chambers, where the reaction is completed by the injection of steam or, preferably, atomized water at the inlet pipe. The vigorous reaction, which proceeds according to the second of the equations given, produces a heavy mist of sulphuric acid, which slowly settles. The unreacted gases, together with the nitrogen oxides released, pass to the succeeding chamber. In the reaction chambers the concentration of the reactants is so regulated that 55° Bé acid forms. This is drawn off from the chamber floor and shipped, or returned to the Glover tower for concentration to 60° Bé.

Actually, a small percentage of the total acid formed in the chamber process is produced in the Glover tower. Observation that the cooler portions of this tower and of the lead chambers are particularly favorable for the formation of acid resulted in the chamber process being subjected to modifications. These, in their extreme form, eliminate entirely the air-cooled lead chambers. For example, the Anaconda packed cell towers comprise acid-cooled towers packed with acidproof brick. In the Mills-Packard chambers, characterized by a truncated-cone shape, the chamber reaction is promoted by water cooling; water flows over the exterior of the towers.

**Gay-Lussac Tower.** Gases from the reaction chambers pass to the Gay-Lussac tower, the purpose of which is to recover the major portion of the nitrogen oxides. Constructed of lead-lined steel or acidproof brick, the Gay-Lussac tower is packed with graduated lumps of quartz or acid-resisting stoneware. The size of the packing material decreases with the height in the tower, as is the custom where it is desired that more intimate contact be obtained between absorbent and the substance being absorbed, as the latter decreases in concentration. Cold Glover acid, introduced at the top, is the absorbent which is used for recovering the rising nitrogen oxide gases.

**Concentrating the Acid.** Chamber acid may be concentrated to a maximum strength of 66° Bé. by evaporation, as in a series of pans set stepwise over a suitable source of heat, or by injection of hot gases to remove water. It is also possible to pass the gas in countercurrent to hot gases down a tower packed with quartz. Concentration above 66° Bé. is not possible, however, because the acid has a tendency to decompose on continued evaporation.

Basically the formation of sulphuric acid is brought about by three reactions:

$$\underset{\text{Sulphur}}{S} + \underset{\text{Oxygen}}{O_2} = \underset{\text{Sulphur dioxide}}{SO_2} \quad (1)$$

$$\underset{\text{Sulphur dioxide}}{SO_2} + \tfrac{1}{2}\underset{\text{Oxygen}}{O_2} = \underset{\text{Sulphur trioxide}}{SO_3} \quad (2)$$

$$\underset{\text{Sulphur trioxide}}{SO_3} + \underset{\text{Water}}{H_2O} = \underset{\text{Sulphuric acid}}{H_2SO_4} \quad (3)$$

The second reaction is the difficult one. Essentially, it is realized in the chamber process by nitric oxides through the intermediate formation of nitrosyl sulphuric acid.

## CONTACT PROCESS

The contact process, introduced in Germany in 1901, effects the oxidation of sulphur dioxide to sulphur trioxide with the aid of a solid catalyst. As is typical of such catalytic processes, a relatively large surface of contact material is required, by comparison with the total quantity of catalyst present in the reaction chamber. For this reason, it is the practice to use a catalyst in suitable form for extension over a large area of inert substance, such as asbestos, silica gel, or magnesium sulphate. Three catalysts in particular have been used for the contact process of manufacturing sulphuric acid: iron oxide, platinum, and vanadium compounds of the vanadium pentoxide class, to list them in their order of increasing importance.

**Reaction Conditions.** Sulphur dioxide oxidizes to sulphur trioxide with evolution of heat—45,200 cal. At the same time, the reaction is a reversible one, favored by the presence of an excess of oxygen. As much as 150 to 200 per cent of oxygen over the amount called for by the reaction equation is used. While the rate of formation of sulphur trioxide is accelerated by temperatures above 400° C., the reverse reaction is likewise favored at higher temperatures, with the result that an optimum temperature between 400 and 500° C. is usually maintained. In a refinement of this technique, some plants even promote the formation of sulphur dioxide by carrying out the initial phase of the reaction at temperatures of 500° C., and over. As conversion nears completion, the gases are cooled to impede decomposition of the sulphur trioxide formed. In the contact process, this conversion of sulphur dioxide to sulphur trioxide may reach from 96 to 97 per cent.

**Catalysts and Poisons.** As in the great majority of catalytic reactions, one of the chief problems in the contact process is the protection of the catalyst from poisoning by impurities in the sulphur dioxide gases. For this reason, in the past, over 50 per cent of the sulphur dioxide produced in the manufacture of contact acid has been made from brimstone. From the standpoint of economic utilization of national resources, however, such practice is considered extravagant, and pyrites are gradually being adopted as sources of sulphur—suitable provisions being taken for the effective removal of catalyst-toxic impurities from the sulphurous gases produced. Dust, moisture, arsenic, and the halogens are among the worst offenders as catalyst poisons. The hot, dust-laden, sulphurous gases therefore pass from the burners into chambers, where baffles cause the precipitation of the dust particles. Cyclone- and electrostatic-type dust collectors may also be installed in the circuit. The gases, freed of dust, then pass to scrubbers, constructed of lead in a manner similar to the Glover towers. In these, a downward flow of acid removes the other impurities: dilute acid is required to eliminate the halogens and arsenic; concentrated acid, moisture and any traces of metal present.

**Heat Exchangers.** To bring the purified gases up to the optimum reaction temperatures, a series of heat exchangers is used. Heat exchangers are essentially enclosed pipes through which flow in countercurrent the cold and hot gases. Thus, the cold gases may pass to the interior of a heat exchanger where they circulate around pipes through which the hot, spent reaction gases flow. The cold gases are thereby preheated and pass to the converter. The converter may be described as an enclosed unit packed with catalyst, or in which the catalyst is distributed on trays, facilitating contact with the rising gases. When the conversion is effected in two phases, first at higher and then at lower temperatures, the reaction gases may pass from the converter to the heat exchanger or preheater, where they not only heat the incoming gases but also complete their reaction.

**Absorption of Sulphur Trioxide.** The reaction gases finally pass to absorption towers packed with stoneware, over which falls a rain of concentrated acid. It is necessary to absorb sulphur trioxide in concentrated acid because of its high heat of solution in dilute acid or water. Even with the use of concentrated acid as absorbent, cooling of the issuing acid is necessary. Gases which escape absorption in the first tower may be passed to successive absorption towers to form acids of lower concentrations.

## COMMERCIAL ACIDS

It is possible, for example, to produce acids of 93 to 98 per cent content, 20 per cent oleum, and even 40 per cent oleum by the contact process. Oleum is a solution of sulphur trioxide in sulphuric acid; it is also known as fuming sulphuric acid. Equimolecular proportions of sulphur trioxide and sulphuric acid combine to form pyrosulphuric acid, $H_2S_2O_7$, a solid crystalline compound.

Pure sulphuric acid (hydrogen sulphate) dissociates to sulphur trioxide and water when heated above 100° C., until a constant-boiling mixture containing 98.33 per cent sulphuric acid is obtained. The mixture boils at 338°C. (640° F.).

When concentrated sulphuric acid is diluted with water, there is considerable evolution of heat. Safe practice dictates that such dilutions be made by adding the sulphuric acid to water (not water to acid), with constant stirring.

## CHEMICAL BEHAVIOR AND USES

The normal acid action of sulphuric acid on metals depends upon its concentration. In dilute solutions, metals preceding hydrogen in the electromotive series are attacked by sulphuric acid with formation of the metal sulphate and liberation of hydrogen. Concentrated solutions of sulphuric acid, however, attack many metals, regardless of their position in the electromotive series, to give the metal sulphate and water, with liberation of sulphur dioxide formed during an intermediate oxidation of the metal by sulphuric acid.

Sulphuric acid owes its extensive use largely to three important properties: (1) it is hygroscopic; (2) it is a strong acid; and (3) it is a powerful oxidizing agent.

The avidity of sulphuric acid for water is utilized in industry in the concentration of nitric acid and in nitration reactions. Moisture is removed from gases in towers using sulphuric acid as scrubber.

The action of dilute sulphuric acid on metals is applied in the metal-finishing trades for pickling metal surfaces prior to plating and other finishing treatments. The property possessed by sulphuric acid of displacing lower-boiling acids

from their salts is utilized in the manufacture of these acids. The most important application, however, is its use in the conversion of insoluble phosphate rock to soluble calcium phosphates for use as fertilizers. Approximately one third of the sulphuric acid consumed in the United States goes to the fertilizer industry.

Concentrated sulphuric acid, as an oxidizing agent, chars most organic substances, such as sugar, wood, and cotton. This property has been used in the petroleum industry in the purification of various fractionation products by agitation with 66° Bé. acid, followed by water washing and neutralization with dilute caustic soda. In the dyestuff industry, sulphuric acid serves largely as a sulphonating agent.

Electrolysis of dilute solutions of sulphuric acid liberates hydrogen at the cathode and forms persulphuric acid, $H_2S_2O_8$, at the anode. On hydrolysis, the persulphuric acid is decomposed to hydrogen peroxide and sulphuric acid, which returns to the electrolytic cells.

A common use of sulphuric acid is made in the electrolyte of the lead-cell storage battery. *See also* Storage Battery, Electrical; Sulphur. J. Se.

**SULPHUR SPRINGS,** a city in northeastern Texas, the county seat of Hopkins Co., located 85 mi. northeast of Dallas. It is served by the St. Louis Southwestern and the Louisiana & Arkansas railroads. Cotton, grain, fruit, and truck crops are the chief agricultural products of the region. The city has a cottonseed-oil mill, a meat-packing plant, and cheese and canning factories. Pop. 1950, 8,991.

**SUL PONTICELLO.** *See* Musical Terms.
**SUL TASTO.** *See* Musical Terms.
**SULUBBA.** *See* Asiatic Tribes (*Semitic*).

**SULU SEA** [su'lu], a relatively shallow, island-and-reef-studded, tropical body of water, lying between the Philippine Islands and Borneo. It is enclosed by the island of Palawan on the west and northwest, Mindoro and Panay islands on the north and northeast, Mindanao Island on the east, and the Sulu Archipelago and Borneo on the southeast and south. The Sulu Sea connects to the southward with the Celebes Sea, eastward with the Mindanao Sea and the Pacific Ocean, northeastward with the Visayan Sea, and northward and westward with the South China Sea. Its greatest depth is 15,900 ft. The Sulu Sea was the scene of a battle between the United States and Japanese naval and air forces during World War II. R. G. B.

**SUMAC** [shu'mæk; syu'mæk; su'mæk], common name of a large genus, *Rhus,* of trees and shrubs of the cashew family, native chiefly to subtropical and warm temperate regions. They are shrubs or medium-sized trees, having leaves usually pinnate, and greenish or whitish flowers, often in dense terminal panicles. The one-seeded fruits are dry and small, often a showy red. The tan sumac, *R. coriaria,* of southern Europe, is grown for its leaves and for its bark, which is used in tanning and dyeing. Common throughout much of eastern North America are the smooth sumac, *R. glabra,* and the staghorn sumac, *R. typhina,* both large shrubs which are planted for ornament, in different varieties, because of their brilliant fall color. The shining sumac, *R. copallina,* a shrub or small tree of eastern North America having glossy foliage which turns red in autumn, is also used as an ornamental. Among the sumacs of the Pacific states are the laurel sumac, *R. laurina;* the sugar bush, *R. ovata;* and the lemonade berry, *R. intergrifolia,* all attractive shrubs having evergreen leaves.

A group of poisonous plants, *Toxicodendron,* is sometimes included with the sumacs. Important economically is the lacquer tree of eastern Asia, *T. verniciflua,* the source of Japan lacquer, and the Japanese wax tree, *T. succedaneum,* the crushed berries of which are a source of wax. The poisonous species native to North America are called poison ivy, poison oak, and poison sumac. *See also* Fustic; Poison Ivy. J. C. Wis.

**SUMATRA** [sumɑ'trə], the westernmost large island of the Malay Archipelago, in the Republic of Indonesia. It has a northwest-southeast axis and is almost exactly bisected by the equator. The Strait of Malacca separates it from Malaya to the northeast and Soenda Strait from Java to the southeast; the southwestern coast faces the Indian Ocean. Sixth largest of the world's islands, Sumatra has an area of approximately 167,500 sq. mi.; its greatest length is 1,060 mi. and its greatest width, 248 mi.

**Topography.** Less developed and as a whole less fertile than Java, Sumatra along its southwestern side is a series of parallel mountain ranges collectively known as the Barisan Mountains (Bukit Barisan), which are interspersed with 12 active and 78 inactive volcanoes as well as with fertile tuff plateaus. The highest peak is Mount Kerintj (12,467 ft.). The eastern coast, a vast swampy lowland, is crossed by wide meandering rivers, such as the Kampar, Inderagiri, and Moesi, and is covered by thick forests and dotted with many rubber plantations. The area is rich in petroleum; the Palembang area has coal and lignite. The soil of Sumatra is agriculturally useless except at the southeastern (Lampong) and northeastern (Medan) extremities. The flora and fauna of the island are similar to those of Java.

**Climate.** The climate is primarily equatorial with most of the rain coming in those regions where the regular monsoons have been broken up by the lofty Barisan Mountains. In the extreme north and south the monsoonal climate, with one relatively drier season, occurs. Rainfall varies between less than 60 in. in the Toba Lake region to over 200 in. in the Lebong area. The highest temperatures are registered during the relatively drier seasons, but the average monthly difference is never greater than 2° F. On the lowland plains the temperature ranges between 70° and 88° F.

**Ethnology and Population.** In 1950 the population of Sumatra was estimated at 11,000,000. In the ethnic composition of the people, Veddoid traces of pre-Malayan inhabitants are still to be found in the inaccessible forests of the eastern plain. The interior highlands as well as the western islands reveal indications of other ancient races, such as the Caucasian and the Niasese (200,000), the latter, it is believed, being remotely related to the Maoris and Tahitians of the Pacific, whereas the proto-Malay Bataks (1,600,000) of the Toba Lake region abound in Dravidian and Melanesian types. The Malays (4,000,000) are in the majority practically everywhere. Originally coming from Asia to settle in central Sumatra, they later spread from this center, particularly into eastern Sumatra. The highland Minangkabau (2,700,000), a matriarchal society, observe the highest elements of their original culture. The Redjang-Lampong (1,000,000) of the southern tip of the island apparently once belonged to the Batak but were separated from them when later Malays drove a wedge between. Hindu and Hindu-Javanese culture and Sudanese blood from Java have deeply affected this ethnic group. The Achinese (1,200,000) of the northwestern coastal strip are a Malay-Indo-Arabian amalgam and show a clear Semitic strain. The coastal Malays, last comers of them all, occupy all the remaining parts of Sumatra, except for some highland regions which are

BOB LANDBACH FROM BLACK STAR

*Carabao are worked as beasts of burden on the island of Sumatra.*

inhabited by many other small tribes such as the Lebong, Kurinchi, Gajos, and Alas. Besides these there were approximately 1,000,000 Javanese and Sudanese, 400,000 Chinese and other Asiatics, chiefly Arabians, and a few thousand Europeans. The largest cities on the island are Palembang (150,000), Medan (125,000), and Padang (60,000).

The population is predominantly Mohammedan, except for the peoples living on the small islands to the west and two-thirds of the Bataks. One half of this group of Bataks is Christian; the remainder still adheres to animistic beliefs.

**Economic Activities.** Irrigated and nonirrigated rice and maize, especially in the Batik highlands, are the chief subsistence crops, whereas rubber, pepper, copra, coffee, tobacco, cotton, kapok, cloves, nutmeg, gambier, tea, oil palms, sisal, cinchona, cocoa, and ground and beetle nuts are grown, mainly for export, in northeastern Sumatra and in the highlands of Tapanuli and Padang. Gutta percha, various resins, gums, valuable timber, and birds' nests for Chinese consumption also form part of the domestic consumption. Pigs are kept only by non-Mohammedans, and there are few cattle. Fishing, both fresh and salt water, forms an important part of the economy.

Coal is mined in the Padang highlands and near Palembang. Oil is found along the eastern plain from Achin to Palembang. Gold and silver are mined in the vicinity of Benkoelen. E. J. C. K. de J.

**History.** Sumatra was one of the first islands of the Malay Archipelago to be settled by Hindu immigrants, and by the seventh century the powerful kingdom of Srividjaya, with its capital near the present city of Palembang, had been established in eastern Sumatra. Ruled by the Shailendras dynasty, the kingdom was for many centuries the mightiest maritime power in the archipelago, extending its influence over the greater part of Sumatra, Java, and peninsular Malacca, and controlling the strategic Strait of Malacca. Its prosperity lasted until the end of the thirteenth century, when the Javanese kingdom of Modjopahit established hegemony. Javanese colonists then penetrated the former kingdom, while at about the same time the Arabs first invaded northern Sumatra (Achin). Marco Polo, who visited the island in 1291, first reported the Mohammedan penetration; in the early part of the sixteenth century the Portuguese established trading relations with the rulers of Achin, who were then becoming increasingly powerful. The sultanate reached its height in the reign (1607-1636) of Sultan Iskandar Muda, when it controlled the greater part of the island.

The English first visited Achin in 1602, and in 1663 the Dutch established settlements on the west coast. In the time of the United East Indies Company (1602-1800) Sumatra's role in colonial policy was slight, except for almost continuous commercial rivalry with the British, who had also established settlements near Benkoelen. In 1819 the British concluded a treaty with the Achinese whereby other European powers were to be excluded from the kingdom, but in 1824 they handed over their rights in Sumatra to the Dutch in exchange for Malacca. Gradually the several lesser kingdoms on the island were subdued, but Achin was not suppressed until 1900, after a war lasting thirty years and costing some 250,000 lives. The Dutch, however, were never able to secure effective control of more than the coastal area.

During World War II, from 1942 to 1945, Sumatra was occupied by Japan. Following the defeat of the Japanese, the island came under the authority of the newly created Republic of Indonesia, and with the formation of the United States of Indonesia, in December 1949, its several states became a part of the new federation. With the end of the federation in 1950, when all the separate states ceased to exist and became a part of the Republic of Indonesia, Sumatra was divided into three provinces (North, Central, and South Sumatra), under which are eleven residencies. Each province is administered by a governor responsible to the central government at Jakarta, the capital of the republic. C. W. D.

**SUMBA.** *See* SOEMBA.

**SUMBAWA.** *See* SOEMBAWA.

**SUMERIAN** [sumɪ′ərɪən], a language spoken in Babylonia at the time when cuneiform writing developed from primitive picture-writing into a standardized script. To judge from the evidence of place names, it was spoken over most of Mesopotamia during the fourth millennium B.C., especially by the settled population. Its old rival, Accadian, or Semitic Babylonian, gained the upper hand about 2400 B.C., and Sumerian became extinct as a spoken tongue soon after 2000 B.C. It survived, however, as a learned language to about the Christian Era, if not even later.

Sumerian was identified as a separate language by Assyriologists soon after the decipherment of the cuneiform script. After about fifty years of slow progress, its interpretation has advanced steadily since 1900. Today, thanks particularly to the work of F. Thureau-Dangin, Arno Poebel, and the latter's pupil, S. N. Kramer, Sumerian can be read with little difficulty, though there are still unknown words and obscure passages. The language shows no family relationship to any other known language, ancient or modern; at the dawn of history it had already broken down phonetically to such an extent that many originally distinct words had fallen together in pronunciation. Such words seem to have been distinguished by the use of different accents or tones, much as in Chinese. Structurally, Sumerian shows a strong agglutinative tendency to incorporate nonverbal elements into a verbal complex, as in Turkish. Since Sumerian was the dominant language in what was perhaps the earliest culture of the Old World, it is not surprising that it strongly influenced the Semitic languages which successively followed it as vehicles of higher culture. Accadian, Aramaic, Arabic, and Hebrew

contain many words of Sumerian origin, generally relating to the arts and crafts. W. F. A.

**SUMERIANS** [sumɪ′əriənz], first civilized inhabitants of ancient Babylonia (modern Iraq). Perhaps as early as 5000 B.C. the Sumerians came from the east or descended from the mountains of Elam to the swampy plain (ancient Sumer) at the head of the Persian Gulf. They drained the swamps, instituted flood control, and established agriculture on a permanent basis. With the development of trade with surrounding areas—Iran, Elam, Assyria, India, and the Mediterranean coast—the Sumerian settlements grew into prosperous city states which by 3500 B.C. possessed a mature civilization characterized by urban life, metal working, textile manufacture, monumental architecture, and an efficient system of writing.

The Sumerian states were theocratic; each state was considered the property of a particular local god who was represented on earth by a high priest (*patesi*) who was the religious and governmental head of his community and its surrounding territory. Geographic areas of great importance in this early period were the cities of Ur, Erech, Umma, Eridu, Lagash, Nippur, Sippar, and Akkad, a Semitic state in the north. Interstate wars were common, and sometimes brief local empires were established when one state would conquer a few of its neighbors. About the middle of the third millennium B.C., however, Semitic tribes from the Arabian Peninsula, who had settled in northern Babylonia and adopted Sumerian culture, became strong enough to endanger Sumerian independence. Sargon of Akkad, about 2650 B.C., conquered the Sumerians and carved out an empire which stretched from the Persian Gulf to the Mediterranean Sea. After perhaps 2500 B.C., however, the Akkadian power declined, and a new period of independence and prosperity began for the Sumerians; this is the era of the Third Dynasty of Ur and the greatness of Lagash under Gudea. The end came about 2000 B.C. with the rise of the Amorite kingdom, a new Semitic state with its capital at Babylon; the Sumerians lost their independence forever, and the old areas of Sumer and Akkad were swallowed up by the empire of Hammurabi.

Although the Sumerians disappeared as a people and their language ceased to be spoken in Babylonia, their system of writing (cuneiform) and many elements of their religion still formed an integral part of Babylonian, and, later, Assyrian, culture. They had laid the foundations for the civilization of a large part of the Near East, and the business organization, technology, and scientific knowledge which they bequeathed to their successors was very important. *See also* BABYLONIAN AND ASSYRIAN ART. T. B. J.

**SUMMER.** *See* SEASONS.

**SUMMER CYPRESS,** also called mock cypress and burning bush, a bushy annual plant which grows about 5 ft. high. A member of the genus *Kochia* of the goosefoot family, it has narrow leaves which turn deep red in autumn. J. C. Wis.

**SUMMER FLOUNDER.** *See* FLUKE, OR SUMMER FLOUNDER.

**SUMMERSIDE,** a port town in Prince Co., Prince Edward Island, Canada, situated on Bedeque Bay, 36 mi. west of Charlottetown and 124 mi. north of Halifax, Nova Scotia. It is served by the Canadian National Railways, which maintains a ferry service from near-by Port Borden to Cape Tormentine on the mainland of New Brunswick. Potatoes, dairy products, silver fox furs, and the celebrated Malpeque oysters are products of the region. Summerside is a tourist resort, a trading center, and a farmer's supply point for the western end of the island. It was incorporated in 1903. Pop. 1951, 6,547. D. F. P.

**SUMMIT,** a village in northeastern Illinois, situated in Cook Co., at the crest of the watershed between the Mississippi and the Great Lakes, on the Illinois and Michigan Canal. Summit lies 10 mi. southwest of the heart of Chicago, of which it is an important suburb. Limestone is a natural resource of the region. The local government is the mayor-councilmanic type. Summit was incorporated as a village about 1890. Transportation is provided by the Gulf, Mobile and Ohio Railroad. The city is the site of one of the largest corn refineries in the world. Besides corn products, its industries produce chemicals and paints. Pop. 1950, 8,957.

**SUMMIT,** a residential city in northeastern New Jersey, situated in Union Co., on the crest of one of a series of hills popularly known as First Watchung Mountain, near the Passaic River, 10 mi. southwest of Newark, and 19 mi. southwest of New York City. The surrounding area is devoted to general farming. Founded about 1795, Summit was incorporated as a city in 1899. A mayor and city council govern the city. Strategically important in relation to western New Jersey during the Revolutionary War, the ridge of First Watchung Mountain was a vital observation post from which General Washington's lookout men would warn of any approaching British raiders. A marker commemorates the site of a small cannon which was used as a warning gun. Transportation is furnished by the Delaware, Lackawanna and Western, and the Rahway Valley railroads. Local factories manufacture chemicals, silk, aprons, and knit goods. Pop. 1950, 17,929.

**SUMMIT HILL,** a borough in Carbon Co., in eastern Pennsylvania, 27 mi. northwest of Allentown. It is served by the Lehigh and New England Railroad for freight transportation. Anthracite was discovered in the valley in 1776, and the deposits proved so extensive that coal mining continues as the sole industry of the region. The famous Burning Mine in the vicinity was on fire for more than a century. Summit Hill's Mauch Chunk Switch-Back railway, now abandoned but which had its first run in 1827, was one of the first railroads to be built in the United States. Summit Hill was incorporated in 1889. Pop. 1950, 4,924.

**SUMMONS.** *See* LEGAL PROCEDURE.

**SUMNER, CHARLES** (1811-1874), United States senator, was born in Boston, Mass., Jan. 6, 1811. He was educated at Harvard University, received his law degree in 1833, and was admitted to the bar in 1834. A good orator, he made many speeches attacking slavery, and spoke in opposition to the annexation of Texas in 1845 and against participation in the War with Mexico. He helped to organize the Free Soil Party in 1848 and in 1851 was elected to the United States Senate from Massachusetts. His caustic speeches attacking slavery prompted Representative Preston Brooks of South Carolina to attack Sumner bodily in 1856; Sumner never fully recovered from the injuries he received at that time. After Lincoln's election to the presidency in 1860 Sumner was a principal champion of the abolitionist cause in Congress. In 1861 he helped to achieve a peaceful

settlement of the international dispute arising from the Federal seizure of Confederate agents from a British ship during the American Civil War. Sumner was a strong advocate of Congressional superiority and felt that Congress, rather than the President, should be responsible for the reconstruction of the South after the end of the Civil War. A Radical Republican, he participated in the attempted impeachment

CHARLES SUMNER

BROWN BROTHERS

of President Andrew Johnson. In 1871, during Ulysses S. Grant's first presidential term, Sumner opposed the Administration's plan to annex Santo Domingo and opposed Grant in the presidential election of 1872. Summer died in Washington, D. C., Mar. 11, 1874. W. E. A.

**SUMTER,** a city in central South Carolina, the county seat of Sumter Co., situated in a rich agricultural area, 45 mi. east of Columbia. The region is heavily forested, furnishing the basis of much of the city's industry. Founded in 1799, Sumter was incorporated as a city in 1833. The city government is the council-manager type. Located in the city is the tomb of General Thomas Sumter, a hero of the Revolutionary War. In the vicinity is the Poinsett State Park. Sumter is the seat of Morris College for Negroes. Transportation is furnished by the Atlantic Coast Line and the Seaboard Airline railroads. In addition to furniture, the local factory output includes flooring, sash doors, lumber, cotton, cottonseed-oil products, machinery, veneer, garment hangers, caskets, trousers, and barrels. Pop. 1950, 20,185.

**SUMY** [su′mɪ], the name of a region and its administrative center in the northeastern Ukrainian S.S.R., in the western Soviet Union.

**The City.** Sumy is located approximately 90 mi. northwest of Kharkov. It is situated at the confluence of the Souma and Soumka rivers, on a bank of the Psel, in a dissected plain. Founded about 1652 by Ukrainian emigrants on the site of Lipensky, a village many centuries older, it suffered from Tatar invasions in 1658 and 1669. It became an important trading point for grain and held annual fairs which were widely popular. During World War II it was the scene of heavy fighting and was occupied by Nazi forces for several months. Sumy has good rail connections and trades in grain and sugar beets. Products include sugar, flour, agricultural machinery, textiles, leather, and lumber. Pop. (est. 1950), 70,000. C. C. H.

**The Region.** The Sumy Oblast (Region) is bounded by the oblasts of Bryansk on the northwest and north, Kursk on the east, Kharkov on the southeast, Poltava on the southwest, and Chernigov on the west. It covers an area of 14,818 sq. mi. The regional economy consists primarily of agriculture—cereals of all kinds, and industrial plants such as tobacco, flax, and hemp. The region produces large quantities of vegetables and a variety of livestock. Processing of tobacco, sugar, alcohol, flour, lumber, and food constitute the main industries. The industrial centers of the region are Sumy, Romny, and Konotop. Pop. (est. 1954), 1,800,000. W. S. V.

**SUN.** *See* SOLAR SYSTEM.

**SUNBIRD,** any one of a great number of species of small or very small (6 in. or less) songbirds united in the family Nectariniidae and allied to the flowerpeckers and honey eaters. It inhabits the tropical regions of Africa, Asia, and Australasia, and is characterized by a fairly long, curved bill and a tubular, protrusible tongue. The sexes are almost always differently colored, and the males have combinations of brilliant, often metallic, colors. As might be expected from its bill and tongue, it feeds wholly on the nectar of flowers and the small insects attracted thereto. Sunbirds have short, rather grating songs. Their nests are elaborate, hanging, purselike structures, often adorned with "tails" of cobweb and grass. In their food habits and iridescent plumage they closely resemble the hummingbirds of the New World, although the two families are in no way related to each other. H. G. De.

**SUN BITTERN,** a peculiar bird, *Eurypyga helias,* allied to the rails and cranes, found, in several varieties, from Guatemala to Brazil. It is about the size of a small heron, with a slender bill, a rather long, broad tail, and broad, rounded wings. It has a black head, with a white stripe above and below each eye, and a white throat. The rest of the plumage is an indescribable mothlike mixture of black, white, brown, gray, chestnut, and buff. It inhabits the wooded banks of streams, where it feeds on insects and small aquatic animals. During the season of courtship the wings and tail are expanded to display their curious markings. H. G. De.

**SUNBURY** [sʌ′nbəri], a city in east central Pennsylvania, the county seat of Northumberland Co., situated at the confluence of the north and west branches of the Susquehanna River, 42 mi. north of Harrisburg. The city is a shipping center for the coal and farm products of a wide territory. Founded in 1772 where Shamokin, an Indian village, once stood, Sunbury was incorporated as a borough in 1797 and as a city in 1922. The city government is the commission type. At Fort Augusta, built on the site of the city in 1756, the power of the French was broken during the French and Indian War. The fort became the refuge for survivors of the Wyoming Massacre. In Sunbury Thomas A. Edison in 1883 built and put into operation the first 3-wire, central station, electric-lighting plant in the world. Transportation is provided by the Delaware, Lackawanna and Western, the Pennsylvania, and the Reading railroads. Machine parts, silk, clothing, insecticides, and caskets are manufactured. Pop. 1950, 15,570.

**SUNDA ISLANDS** [sʌ′ndə], a chain of islands forming the Malay archipelago, which stretches eastward from the Malay peninsula to, but not including, the Molucca Islands, 7° N. - 11° S. lat., 95° - 128° E. long. The islands sepa-

rate the Pacific Ocean and its marginal seas from the Indian Ocean, and form the major part of the Republic of Indonesia. They are divided into the Greater Sunda Islands (Sumatra, Java, Borneo, Celebes, and adjacent small islands) and the Lesser Sunda Islands (Bali, Lombok, Soembawa, Soemba, Flores, Timor, and lesser islands in their vicinity). They are inhabited by nearly 70,000,000 people, over 49,000,000 of whom live on Java alone. R. G. B.

**SUNDAY, WILLIAM ASHLEY** (1862-1935), American evangelist, popularly known as Billy Sunday, was born in Ames, Iowa, on Nov. 18, 1862. He spent part of his boyhood in two orphan homes and worked his way through high school. His proficiency in baseball while playing on a local team in Marshalltown, Iowa, led him to a career in professional baseball, and from 1883 to 1891 he played successively on teams in Chicago, Pittsburgh, and Philadelphia. Sunday was converted in 1887 in a Chicago mission and after 1891 devoted himself to religious work, first in the Y.M.C.A. and after 1896 as a preacher. In 1903 he was ordained in the Presbyterian ministry and rapidly developed into the most widely known evangelist of his time. Utilizing a high-powered organization in carrying on his revivals, he attracted immense throngs and gained headlines in the newspapers. The number converted under his preaching is estimated at 300,000. Sunday's dramatic denunciation of the saloon and alcohol played a conspicuous part in his work and was a major influence in the adoption of the Eighteenth Amendment and of the "dry" experiment which followed. He died in Chicago on Nov. 6, 1935. W. W. S.

**SUNDAY.** To understand the meaning and significance of Sunday as the first day of the week it is necessary to consider the five contributions which have been made to its place in the calendar and to its manner of observance: (1) the worship of the sun among ancient peoples, (2) the popularity of Mithraism among the Romans, (3) the Roman observance of the day of the Sun, (4) the early Christian dedication of the first day of the week as a memorial of the resurrection of Christ, and (5) the Scottish Presbyterian conception of Sunday as a day of rest and the adoption of this conception by Puritan Massachusetts, with the resulting Sunday laws, usually known as Blue Laws.

From prehistoric times to the close of the fifth century of the Christian Era the worship of the sun was dominant. Deified in Egypt as Ra, the Sun-god, he is pictured in the oldest passages of the Pyramid texts. The sun-disk (Aten) with the outspread wings of the falcon became the most generally used symbol of Egyptian religion and has come to be widely known through such Biblical imagery as "the wings of the morning," and "the sun of righteousness . . . with healing in his wings." In Babylonia, cylinder seals picture the sun as a deity coming forth through open doors which attendants hold open for him, at the same time turning their faces away so as not to be blinded by his brightness. This idea of the sun having a habitation is reflected in the Biblical reference to his coming forth as a bridegroom from his chamber rejoicing as a strong man to run his course. When the Israelites entered Palestine they found the worship of the sun under the name of Baal-hammon, the latter part of this title meaning sun images. The sun was *baal,* or lord, just as the Babylonian sun-god Samas bore the title of *belu,* lord. It is of interest that in II Kings xxiii:11 there is a reference to the chariots of the sun. At the temple of the sun in Sippar in Babylonia there was also a chariot and horses dedicated to the god. Among the Hebrews were many idolatrous Jews who worshipped the sun, attracted to sun-worship under the influence of its frequency among the people of Canaan, and although laws were enacted against the practice (Deut. iv:19 and xvii:25), open idolatry continued long throughout Hebrew history.

At an early unknown date the mystery cult of Mithra or Mithras arose in Persia. In Zoroastrianism he is named Yazata, a power of light serving as aide to Ahura-Mazda. In the valley of the Euphrates he attained the eminence of an Assyrian god. Mithraism reached Rome in the second century B.C. It became popular in the Roman army, in the commercial class, and among the slaves and eventually was adopted by the Roman emperors because it supported the divine right of kings. Mithras, identified with Sol Invictus, gave authority and victory to the throne. From very ancient times, the Romans had marked each eighth day as a holiday. It is not surprising, since they were influenced not only by the favored cult of Mithras but also by the Egyptian cult in North Africa (a cult with which the Roman government was familiar), that they gradually came to observe a holiday dedicated to the sun. *Dies solis* was substituted for *dies saturni.* The earliest known Sunday law appeared in the edict of Constantine (A.D. 321) enacting that "magistrates, city people, and artisans" were to rest on the venerable day of the Sun. This law probably bore no relation to Christianity; the emperor as Pontifex Maximus merely added the day of the Sun to the Roman calendar and thus gave imperial recognition to the sun-worship which was already firmly established in Rome. Constantine's decree allowed agricultural labor on Sunday as work of necessity. The old market day was merged with Sunday. In this connection one may note that markets were held on Sunday in many parts of Europe until the late Middle Ages in spite of numerous papal edicts against them.

The early Christians had first adopted the Jewish seven-day week with its numbered weekdays, but by the close of the third century the planetary week and in the fourth and fifth centuries the pagan calendar names had become general in western Christendom. As noted above, during this same period the spread of Oriental solar religions had led in Rome to the designation of the day of the Sun as the first day of the planetary week. The Christians throughout the Roman world, therefore, had ready to hand a significant day on which to commemorate the resurrection of Christ, the "sun of righteousness." The New Testament contains clear evidence that from a very early period the first day of the week was observed by Christians as a day of assembly for "the breaking of bread" and perhaps for the collection of free-will offerings (Acts xx:7 and I Corinth. xvi:2). Justin Martyr in the middle of the second century describes how "on the day called Sunday" all town and country Christians assembled for instruction in holy writings, for prayer, distribution of bread and wine, and the collection of alms. Tertullian declared that the Christians "made Sunday a day of joy but for other reasons than to adore the sun which was no part of their religion." He was the first Church Father to declare that Christians ought to abstain on Sunday from secular duties and occupations. During the fourth, fifth, and sixth centuries there were numerous imperial decrees declaring with increasing stringency against labor on Sunday. Thus, from early times in its history the Church set aside Sunday as a holy day.

Beginning in the seventh century, strict observance of Sunday was demanded in England and such legislation continued to accumulate until the Act of 1871 which permitted certain kinds of work on the Lord's Day. All of the earlier

laws prohibited all kinds of labor and enforced attendance at church. Heavy penalties were ordered against violators. Particularly severe were the Sunday regulations in Scotland during the Reformation. The day was declared as a time for worship at church and in the home; no work of any kind (even agricultural) was permitted. Influenced by the Scotch standards the Separatists and later the Puritans inveighed against the laxity of Sunday observance countenanced by the Church of England at the time. In the American colonies, Sunday legislation began with an enactment of the Virginia colony in 1617 as an attempt to check the growing indifference toward religion in the spreading plantation. Until very recent times all of the states have passed laws prohibiting business on Sunday, and many states have legislated against sports, games, and the theatre on this day. Practically all of these Sunday or Blue Laws have ceased to be influential. Throughout the United States Sunday continues to be a day of worship. In many Christian communities it is referred to as the Sabbath, and the fourth commandment, "Remember the Sabbath day to keep it holy," is emphasized. Nevertheless, with the coming of the automobile, the moving-picture theatre, radio, and television and the interpretation of rest as relaxation and recreation, American Sunday observance has lost much of its historical austerity. "The Sabbath was made for man and not man for the Sabbath" has acquired broad social and hygienic significance. *See also* Blue Laws. A. L. H-Q.

**SUNDAY SCHOOL,** a type of school which had its historic beginnings in the work of Robert Raikes, a philanthropist of Gloucester, England. In 1780, Raikes established a school on Sunday for the instruction of under-privileged children who worked in factories all week and consequently had no time for school, either secular or religious. There were other contributors to the development of the Sunday school, but Raikes's idea spread more quickly. In the nineteenth century, Sunday-school development spread rapidly over the United States. In many places, then and later, the founding of a Sunday school preceded the establishment of a church. Also, as a result of the great shortage of ministers of the gospel existing at the end of the first half of the twentieth century, Sunday schools remained the only operative factor of some churches. Sunday schools, as the term is generally used, are purely a Protestant phenomena. The parochial schools of the Roman Catholics and of Judaism make provision for religious education, but most Protestant children attend schools where no religious instruction is given. The Sunday school accordingly fills a vital place in Protestantism. Of course, unlike the Sunday school established by Raikes, Sunday schools have become devoted exclusively to religious instruction, since secular instruction is obtained in the regular school curriculum. A. W. S.

**SUNDERLAND,** a seaport and county borough in Durham County, England, located about 10 mi. southeast of South Shields on the North Sea coast at the mouth of the Wear River. The most important commercial center of the county, its main industries are coal exporting and shipbuilding; of secondary commercial importance are breweries and manufactures of ship fittings and clothing. Shipbuilding has declined to some extent since World War II, although the arms of the river afford ideal conditions for shipyards and launchings. The adjacent coalfields of Durham have been extended under the sea near Sunderland, which is second among the Tyneside ports. Sunderland was an important glass-making town in the sixteenth century. The modern city has fine parks, an art gallery, libraries, an impressive Town Hall, and four miles of sandy beach for recreation. The Saxon monastery of Monkswearmouth, founded in 647, was the nucleus of the medieval settlement at Sunderland and the seat of St. Peter's, the famous school of the Venerable Bede, which remains the oldest building in the district. Sunderland returns two members to Parliament. Pop. 1952, 180,400. B. Su.

**SUNDEW,** a large genus, *Drosera,* of insectivorous plants of the sundew family, of which about 100 species are scattered over the world, chiefly in Australia. Seven are native to North America. These plants are perennial bog herbs, usually bearing leaves in a basal rosette and putting forth a slender, naked, flower stalk having a terminal, one-sided cluster of flowers opening only in the sunshine. The leaves, often rounded, are set with curious tentacles ending in reddish heads which secrete a glistening, honeylike fluid. Small insects, especially flies, mistaking the fluid for honey, become entangled in it. Thereupon the tentacles, by a downward movement, place the fly on the surface of the leaf, smother it, and secrete a digestive fluid which enables the leaf to assimilate the proteins of the insect's body and use them for plant food. J. C. Wis.

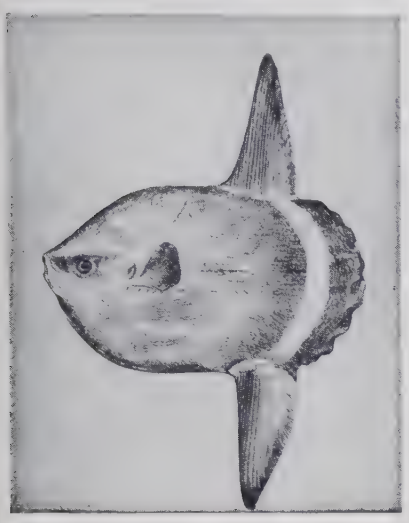
**SUNDOGS.** *See* Atmosphere (*Optical Phenomena*).

**SUNDROPS,** the common name of a genus, *Oenothera,* of the widely distributed evening primrose family. By some botanists, the genus is divided into numerous groups. The sundrops, chiefly native to the two Americas, usually have yellow flowers opening in the day. Various species are grown as ornamentals, especially the Ozark sundrops, *O. missouriensis,* and the common sundrops, *O. fruticosa,* which often have flowers 2 in. across. J. C. Wis.

**SUNFISH,** a small basslike fish of the family Centrarchidae with a deep, compressed body and spiny fin rays. The family is found only in fresh water in North America where there are many species. Some are very brightly colored with reds, oranges, and yellows, particularly during the breeding season in late spring and early summer. All are nest builders. The male clears and hollows out a saucer-shaped depression to a depth of approximately 4 in. He entices a female into the nest with a vigorous courtship. Later, he guards the nest and newly-hatched young. Most sunfish are small in size and seldom exceed 8 in., but are highly regarded as pan fish. All are carnivorous and eat insects, mollusks, crayfishes, and small fishes. Among the best known are the pumpkin seed, or common sunfish, *Eupomotis gibbosus,* and the bluegill, *Lepomis macrochirus.* Natural hybrids occur commonly among sunfishes. *See also* Bream; Crappie. E. C. R.

**SUNFISH, OCEAN,** *Mola mola,* a huge, grotesque fish of the family Molidae that lives in the open seas. It is often called a "headfish" because it gives the appearance of being one large oval head with the large dorsal and anal fins inserted far back on the body. These giant fish reach a length of 10 ft. and weigh more than 2,000 lb. Living near the surface, at times they may be seen lying on their sides basking in the sun. They feed on small fishes, crustaceans, and other small organisms which are picked up as they drift passively about. Often seen, they are easily captured since they permit a boat to come alongside and rarely try to escape by submerging. A thick layer of hard tissue under

the leathery skin helps protect them. The flesh is not generally eaten. A related species, the king of the mackerels, *Ranzania truncata,* a much smaller fish, only about 2 ft. long, has a proportionately longer body. E. C. R.



OCEAN SUNFISH, MOLA MOLA

COURTESY OF THE U. S. FISH AND WILDLIFE SOCIETY

**SUNFLOWER,** a genus, *Helianthus,* of the family Compositae having about 80 species of annual and perennial herbs, chiefly native to North America. The sunflower is a large, coarse plant having rough, triangular leaves which are usually opposite near the ground and alternate higher on the stems. The large flower heads, solitary or in clusters, terminate the stems and consist of a broad central disk of florets surrounded by conspicuous yellow rays. They bloom in autumn, turning each day to follow the sun from east to west.

The common sunflower, *H. annuus,* native from Minnesota to Texas, and state flower of Kansas, is sometimes used ornamentally and has great economic value. It is a rough, hairy annual growing wild, as high as 12 ft. It has toothed leaves 12 in. long, and large flowerheads. In the Soviet Union, its seeds are used for poultry feed. There is a small-seeded variety from which a valuable edible oil is produced, also oil cake for stock feeding, and oil for industrial uses. In the United States, the sunflower is grown sparingly for its seeds, but the plant is used for fodder and ensilage. Under cultivation, the sunflower may reach 17 ft. in height, and may have flower seeds 14 in. in diameter.

The Jerusalem artichoke, *H. tuberosus,* has fleshy roots often used as a vegetable. The willow-leaved sunflower, *H. salicifolius,* a perennial growing 10 ft. high, is native from Nebraska south, and has numerous flowers and attractive, refined leaves. Many hybrid sunflowers are grown for ornamental use. J. C. Wis.

**SUNGARI** [sʊ′ŋgɑ′rɪ′], the principal river of Manchuria. It rises in the mountains of Antung Province, near the northern boundary of Korea, and flows northward into the large Sungari Reservoir; from there it continues in a northwesterly direction to a point near Fuyu, where it is joined by the Nen River and turns sharply northeastward, finally emptying into the Amur River at Tungchiang. The total course of the Sungari is about 800 mi. For most of this distance, the river passes through one of the most fertile valleys of the world, where a large variety of crops, chiefly soybeans, are grown and where a temperate climate, resembling that of the central United States, prevails. Important cities along the river's course include Fuyu, Kirin, Harbin, Tungho, Ilan (Sanhsing) and Chiamussu. The Sungari is deep and usually is navigable by steamboat and junk as far as Kirin. It has numerous tributaries, chief of which is the southward-flowing Nen River. G. Q.

**SUNGKIANG** [sʊ′ŋjɪɑ′ŋ], one of the nine Chinese provinces in Manchuria created after World War II. It was formerly a part of the old Kirin Province. The new province of Sungkiang is situated at the southeastern corner of Manchuria, bordered by Korea on the south, Siberia on the south and east, Hokiang Province on the northeast, Nunkiang Province on the northwest, Kirin Province on the west, and Antung Province on the southwest. It has an area of 31,152 sq. mi. and had a 1947 population of 4,535,000. Mutankiang is the provincial capital.

**Topography and Climate.** The Changpai Mountains extend into this province from Kirin and branch off into three ranges, with Laoyehling in the center, Yingeling in the south, and Siaopaishan in the north. The largest river is the Sungari, which forms the northern boundary with Nunkiang Province. The Mutan Kiang (river), 342 mi. long, comes from Kirin and flows through the province in a northwesterly direction on its way to join the Sungari River in Hokiang Province. The city of Mutankiang is on the right bank of this river. In the south the Tumen Kiang, 286 mi. long and coming from Antung Province, forms a part of the boundary line between Sungkiang and Korea, and then flows through northern Korea to the Sea of Japan. The climate of Sungkiang is essentially continental, despite its proximity to the Sea of Japan. In summer the temperature sometimes reaches 95° F.; in winter it drops as low as —40°; the average winter temperature is —2°. Annual rainfall ranges from 18 in. in the north to 23 in. in the southeast.

**Economic Resources and Activities.** The soybean is the chief agricultural product, and is grown over almost the entire province. The Mutan Kiang Valley provides a fertile land for rice, corn, and tobacco. Ginseng is one of the medicinal herbs produced in Sungkiank. The Mutan Kiang Valley is rich in forests. Total timber reserves there are estimated at 117,250,000 cu. ft., with 40 per cent in Sungkiang Province and the rest equally divided between Kirin and Hokiang provinces. The trees are mostly birch, willow, and pine. Coal is mined in the southeastern part of the province. The largest mine is at Muling, with a reserve of 75,000,000 short tons and an annual output of 360,000 short tons. The Laotoukou mine has a deposit of 25,000,000 short tons and an annual output of 20,000 short tons. The reserves at Tungning and Holung combined are estimated at 190,000,000 short tons, but largely undeveloped. Gold is mined near Harbin, copper at Laotoukou, and silver at Tienpaoshan.

*Transportation.* There are three major railways, with a total of about 650 mi. within the province. The Chinese Changchun Railway, formerly the Chinese Eastern Railway, enters at Harbin and leaves Soviet territory at Suifenho. The Tumen Chiamussu Railway runs from Tumen, on the Korean border, to Chiamussu, on the Sungari River in Hokiang Province. The Kirin-Tumen Railway runs from Kirin, in Kirin Province, to the Korean border. The highways are inadequate. The three main roads are Chuho-Yenshou, Muling-Yenchi, and Mutankiang-Ningan. The Sungari River is navigable by steamboat along its entire length in this province during the summer, but becomes a thoroughfare for vehicles in the winter, when it is frozen. The Mutan Kiang (river) is navigable by wooden craft near the city of Mutankiang, while the Tumen Kiang

is navigable by small steamboat. Being an international river, the Tumen Kiang becomes a waterway of limited use because of official regulations.

**Cities.** Harbin, on the Chinese Changchun Railway and the southern bank of the Sungari River, is a leading metropolis in Manchuria. Since the puppet regime of Manchukuo, it has been made a special municipality, equivalent to a province in status. Situated about 500 mi. from Vladivostok and 600 mi. from Dairen, and linked with both ports by trunk lines of the Chinese Changchun Railway, Harbin became a communications and trade center between China and Russia about the year 1900. Its general appearance and atmosphere show a strong Russian influence. Its 1947 population was about 760,000. Mutankiang, the capital, on the right bank of the Mutan Kiang and at the junction of the Chinese Changchun and Tumen Chiamussu railways, had a 1947 population of 179,217. Many of its residents are Korean and Japanese immigrants. Yenchi, in the south, and Ningan, in the central west, are two other important cities, each with a population of about 27,000. *See also* KIRIN. A. C. T.

**SUNKEN BELL, THE.** *See* VERSUNKENE GLOCKE, DIE.

**SUNN HEMP,** the product of *Crotalaria juncea,* also called Madras and Bombay hemp. Widely used in India, where it is native, sunn hemp often takes the place of jute, and is also used for fish-nets, paper, and fabrics. It is one of the earliest fibers used by men. The plants, whose large, yellow, pealike flowers make them showy when in bloom, are also grown for hay and for green manure crops on many of the islands of the Pacific and in Florida. These shrubs reach a height of 8 ft. J. C. Wis.

**SUNNITE** [su'nait], the most numerous sect of the world-wide community of Islam. The Sunnites acknowledge the *sunnah* (custom, tradition, usage) of the Prophet and his companions. When Mohammed died on June 8, 632, he bequeathed to his followers a religio-political heritage, which gave them the ever-difficult task of finding an acceptable caliph (successor) to fill the highest office in Islam. The Sunnites believed that the theocratic state was an earthly dominion, headed by a caliph or Imam (leader), who was heir only to the secular, temporal office of Mohammed. Since the Prophet was called to his task by divine order, the Sunnites, unlike the Shiites, found it inconceivable that he could bequeath his charismatic mantle to anyone.

The complete silence of Mohammed on the subject of his successors sharpened in later Islamic history the cleavage between the Sunnites and their opponents. The Sunnites recognize the first four caliphs as rightful successors to Mohammed; they accept the six "authentic" books of Hadith (Tradition); and in jurisprudence they form their opinion in conformity with one or other of the four schools of law, which are discussed later in this article.

Constituting the majority of Moslems, the Sunnites have been the principal actors in the long history of the faith. Their first state, centered on Medina (A.D. 632-661), was presided over by valiant, patriarchal figures: abu-Bakr, Omar, Uthman, and Ali, and this initial period of Sunnite supremacy and expansion was encouraged in the establishment of the state of the Ommiads (A.D. 661-750), with Damascus as capital. The Sunnites carried the faith eastward to the frontiers of India, and westward into North Africa and Spain, where they sponsored powerful states. Under the Abbasside Caliphate (750-1258), the Mamelukes of Egypt (1250-1517), and other political regimes, the Sunnites played a most important part in the development of Islamic civilization. With the rise of the Ottoman Turks, who captured Constantinople in 1453 and overran Egypt in 1517, Sunnites continued for more than half a millennium as the stalwart champions of Islam. Since the two World Wars, the Sunnites, even without the caliphal symbol of imperial and spiritual authority, have asserted themselves in international affairs, particularly in relation to the creation of Pakistan.

The peculiarly Islamic science of Hadith (Tradition) owes its inception and growth to Sunnite piety, learning, and ingenuity. Hadith, the body of traditions carried back to Mohammed and his companions, is the basis of Sunnite Islam; Medina, capital city of Mohammed and his immediate successors, was the center of the new science of tradition.

Traditionalists assembled the sayings of Mohammed and his friends in accordance with a undeviating technique. Every tradition consisted of two parts: the *isnad,* a chain of narrators, concluding in the name of the highest authority who heard the saying from the lips of Mohammed or one of his associates, and the *matn,* the utterance as delivered. Bias and dishonesty reduced the value of narrators, but critical care was eventually taken to insure the relative genuineness of Tradition.

The canonization of six reliable books of Tradition crystallized Islamic religious thought. The first impressive compilation was that of al-Bukhari (died 870), a Persian Sunnite who traveled extensively in Arabia, Syria, Iraq, and Egypt, as well as Persia. His countryman, Muslim (died 874), was responsible for a similar collection under the same title. Four subsequent collections, which never acquired the dignity of the first two, were brought together by abu-Dawud of Basra (died 888), al-Tirmidhi (died c. 892), ibn-Majah of Qazwin (died 886), and al-Nasa'i (died 915).

The definitive text of the Koran was finally established in 933. Within the succeeding years, the exegetical works of al-Baydawi (died 1286), and others appeared. As an adjunct to these, the importance of Sunnite Tradition cannot be overrated. It shaped the Islamic heritage and set its religious tone for many centuries.

Equally significant was the formation within the framework of Sunnite Islam of four schools of jurisprudence. This took place during a time when orthodoxy was assailed by Mutazilite rationalism. Of the schools, the Hanafite is the oldest, the most liberal, powerful, and widespread, claiming the adherence of about one-half of the Sunnite population of the world, and prevailing numerically in the Near East, Central Asia, and India. Its founder, abu-Hanifah (700-767), advocated, in the adjudication of cases, the use of analogical deduction, but sanctioned at the same time recourse to "preference," in certain instances, in order to secure equity.

The extreme right wing of Sunnite jurisprudence was represented by the Hanbalites, a school committed to the defense of the fundamental faith against the inroads of freethought and heresy. Except for a few adherents in parts of Africa, this school nearly vanished long ago, but for the Wahhabi revival of the mid-eighteenth century in the heart of Arabia. The Malikite school of jurisprudence also owed its origin to a conservative revulsion against liberalism, though it never went to Hanbalite extremes. Today it prevails in eastern Arabia, North Africa, the Sudan, and Upper Egypt.

At Cairo is the tomb of al-Shafi'i (died 820), founder of a fourth school; and al-Azhar University is the repository of Shafi'ite teaching and its spearhead in the Moslem world. Born in Gaza, Palestine, al-Shafi'i was of Qurayshite origin; he spent his life in Iraq and Egypt. His rite is dominant in Lower Egypt, southern and northern Arabia, East Africa,

and Indonesia as well as the coastal regions of India and Palestine; and his is known as a tolerant, moderate school, cautiously accepting speculation.

The Sunnites—armed with their orthodox faith, exegesis, Koranic dogma, the canonical Tradition, and jurisprudence—fought medieval heresy and rationalism. Since the European Renaissance and the devastating attack upon religion by free inquiry and experimentation, they have sought to evolve a new theology affording the basis for a reasoned faith. Nationalism, secularization, and the impact of the new age, however, have scarcely allowed them the opportunity to refit their religious heritage for the modern world. E. J. J.

**SUNNYVALE,** a city in west central California, in Santa Clara Co., situated 32 mi. southeast of San Francisco. Fruit, poultry, and livestock farms and ranches are found in the surrounding area, for which Sunnyvale is a trade center. A feature of historic interest is the Martin Murphy, Jr., House, the frame of which was built in Boston and shipped around the Horn in 1849. Transportation is furnished by the Southern Pacific Railroad. Local industries include fruit and vegetable canning and the manufacture of road equipment and foundry products. Pop. 1950, 9,829.

**SUN ROSE,** a group, *Helianthemum,* of low woody or herbaceous perennial plants of the rockrose family having delicate roselike flowers whose petals open in the sun and often drop after a day of blooming. Of doubtful hardiness north of Philadelphia, though often grown in rock gardens and borders, the plants are generally evergreen farther south. The leaves are grayish, mostly opposite on the branches, the upper ones sometimes being alternate. The flowers, which have 5 petals, 3 or 5 sepals, and many stamens, are generally yellow, though there are also white, red, and pink forms. Late flowers often have very small petals, or none.

The species most frequently grown are *H. nummularium* and *H. grandiflorum.* The plants thrive in limestone soil, and are easily propagated by greenwood cuttings, by division of roots, or by seeds sown in spring. J. C. Wis.

**SUNSPOTS.** *See* Solar System (*Sun*).

**SUNSTROKE, TREATMENT OF.** *See* First Aid.

**SUN VALLEY,** a town and popular resort in central Idaho, beautifully situated in Blaine Co., 6,000 ft. above sea level, 98 mi. east of Boise, between Sawtooth National Forest and Challis National Forest, at the gateway to the forest and mountain areas of the state. It is internationally famous for its winter sports and is also renowned as a summer resort, with riding, hunting, and fishing that attract thousands. There is even a summer skating rink. The vicinity offers many interesting features, such as the Big Springs pictographs, the Map Rock, Thousand Springs, and Rock Cities. The town was built in 1936 by the Union Pacific Railroad, which serves the town of Ketchum, four miles southwest of Sun Valley. Pop. 1950, 428.

**SUN YAT-SEN** [sʊ′n yɑ′tsɛ′n] (1867-1925), Chinese statesman, first president of the Chinese Republic, was born of a peasant family at Choy Hung, near Macao. Some of his kinsmen had been involved in the Taiping Rebellion (1850-1864), and he himself, while living during boyhood with one of his brothers in Honolulu, Hawaii, became converted to Christianity as a Protestant; from his earliest years, his personality was marked by the double traditions of Chinese revolutionism and Western spirituality. Sun prepared for a medical career, studying in Hong Kong under Sir James Cantlie, a pioneer researcher into the bubonic plague. He was probably the first Chinese ever to qualify for the degree of M.D., but throughout life his practice of medicine was merely incidental to his career as revolutionist.

From his earliest years, Sun Yat-sen had a sense of mission. He felt that he was the man of destiny who would awaken China, restoring its ancient civil virtues and teaching it how to become modern, efficient, productive, and powerful in a world of armed, sovereign nations. His revolutionary technique consisted, first, of the consolidation of the pre-existing anti-Manchu secret societies; second, of their linkage with the modernized Chinese overseas (especially in the United States, the Philippines, Malaya, Japan, and France); third, of the instigation of revolutionary "incidents" which might sweep the torpid masses of China to the revolutionary banner; and fourth, to the planning of a revolutionary administration. In 1894 he called his newly-founded revolutionary confederation the Save China League (Hsing Chung Hui); in 1905 he proclaimed the San Min Chu I and reorganized the party as the League of Common Alliance (Tung Mêng Hui). Sun himself wandered all over the world, studying politics, socialism, land reform, and revolutionary techniques. He gained millions of Chinese followers and became the acknowledged leader of the republicans.

*SUN YAT-SEN*

BROWN BROTHERS

In 1911 an incident at Wuchang precipitated the revolutionary landslide. Sun Yat-sen, then in Denver, Colo., was notified by telegram in code that the revolution had begun and would probably succeed. He returned to China by way of London, seeking British financial support for the emergent republic, and arrived in China in time to take the oath of office as first president of the Republic of China on Jan. 1, 1912. By taking the oath, he lost the American citizenship he had previously gained as an ex-subject of the Hawaiian king.

Following this apparent success, Sun went through years of disappointment. His revolutionary organization, renamed Kuomintang, failed to win control of the new republic. Sun himself relinquished the presidency to the imperial general, Yüan Shih-k'ai, as a means of winning imperial assent to the revolution. Yüan promptly established a pyramid of military dictatorships and began to plot his own enthronement. Sun went into opposition in 1913 and began a succession of revolts, intermittently holding the presidency of unstable revolutionary governments at Canton. He failed to get British or American help in restoration of the republic, and in 1922 accepted the proffered aid of the Third Interna-

tional. With Russian funds, arms, and personnel, the Kuomintang and the Canton government were reorganized. Sun tried to use the Communists while opposing Marxism. In 1924 he gave the lectures which provided the definitive form of the San Min Chu I.

San Min Chu I, the official ideology of both Nationalist and Communist China, is based on the principles of race-nationalism, democracy, and Min Shêng. Race-nationalism, on a basis of Confucian morality joined to Western technical skills and science, was to unite all Chinese throughout the world under the Kuomintang, which was to seek help abroad through alliance with subjugated colonial peoples against the white race (pan-Asianism) and with Communists against capitalism (class war of nations). Sun held that democracy could not be achieved in China simply by giving the vote to the masses, but that its realization must go through three stages: unification by Kuomintang armies, temporary one-party dictatorship by Kuomintang officials, and finally self-government by the free action of the electorate. Min Shêng (or "people living on") was a sort of economic experimentalism, rejecting both unrestrained capitalism and class-war communism. However, Sun's vagueness as to practical measures has allowed a great variety of interpretation of these principles among his followers.

Sun's first wife bore him two daughters and one son, Sun Fo (Sun K'ê). His second, the former Ching-ling Soong, was the sister of T. V. Soong and sister-in-law of H. H. Kung; her youngest sister later married Chiang Kai-shek, who is thus Sun's second wife's brother-in-law. On Mar. 12, 1925, while seeking a negotiated peace with the modern war lords, Sun died in Peiping. Under the honorary name of Chung Shan ("Middle Mountain"), taken from a revolutionary alias, and with the perpetual post, even in death, of Tsung-li ("Party Leader") of the Kuomintang, Sun is recognized by all factions as the greatest Chinese of modern times. His tomb at Nanking, the most spectacular modern building in China, has become a national shrine.

P. M. A. L.

**SUOMI.** *See* FINLAND.

**SUPERIOR,** a port of entry in the northwestern corner of Wisconsin, the county seat of Douglas Co., at the head of Lake Superior, and bounded by the St. Louis and Allouez bays and St. Louis and Nemadji rivers. It is just south of Duluth, Minn., and 125 mi. northwest of Eau Claire. Superior, located in the richest iron-ore district in the nation, is an important shipping center for iron, grain, and coal. The French visited the city's site as early as 1661, and trading posts were established on the point by the Hudson's Bay Company, the Northwestern Fur Company, and John Jacob Astor's American Fur Company, but the permanent settlement of the community did not begin until 1853 when the first log house was constructed. The small settlement became a lumbering and shipping community, which was incorporated as a village in 1887, six years after the first railroad reached the site. Superior was incorporated as a city in 1899; it has the city-manager form of government. The city has a state teachers' college. Superior is not only a leading shipping and industrial city, but it is also a popular resort community because of its location on the lake and its proximity to numerous small lakes and streams with excellent fishing and other recreational facilities. It is in the renowned Northern Woods vacation area of Wisconsin. In the vicinity are the 140-acre Pattison State Park, containing the noted Big Manitou Falls and the Douglas County Upland Bird Sanctuary.

In addition to the lake steamers, the Wisconsin Central, the Northwest, and the Trans-Canada air lines and the Chicago, Milwaukee, St. Paul and Pacific, the Chicago and North Western, the Great Northern, the Duluth, South Shore & Atlantic, the Northern Pacific, and the Minneapolis, St. Paul & Sault Ste. Marie railroads supply transportation. Superior contains three connecting harbors with numerous iron-ore docks, ten coal docks, and eight grain elevators with a capacity of 30,235,000 bu. Shipyards, flour mills, lumber yards, railroad shops, and briquet plants are among the city's chief industrial establishments. Other industrial plants include in their varied output steel products, machinery, furniture and other lumber products, cement, and canvas. Pop. 1950, 35,325.

S. D. M.

**SUPERIOR, LAKE,** the largest body of fresh water in the world, and the northernmost and westernmost of the five Great Lakes of east central North America. Lake Superior is on the Canadian-United States border, and is bounded on the north and east by Ontario, Canada. The Michigan Upper Peninsula and Wisconsin form its southern, and Minnesota its western, boundary. It extends from 46° 25′ to 48° 57′ N. lat. and from 84° 22′ to 92° 06′ W. long. and is 383 mi. long and 160 mi. wide, with an area of 31,820 sq. mi., of which 20,620 are in the United States. The lake surface is 602 ft. above sea level, the maximum depth 1,302 ft., and the average depth about 475 ft. Lake Superior has a fairly regular coastline of 1,500 mi., but has some bays, peninsulas, and islands. The larger bays are Thunder, Black, Nipigon, and Heron on the north coast, and Chequamegon, Whitefish, and Keweenaw on the south. The Keweenaw Peninsula of upper Michigan is the largest in the lake. Sizable islands are Isle Royale, St. Ignace, Simpson, Michipicoten, Cooper, Grand, Manitou, and Slate and the group of Apostle Islands. The drainage basin covers 80,900 sq. mi., of which 37,570 are in the United States.

Lake Superior drains southeastward through the 63-mi. length of the St. Marys River into Lake Huron. The famous Sault Ste. Marie canals built around the mile-long rapids in the St. Mary's River accommodate more commercial freight tonnage than any other canal-system in the world. Cold weather, ice, and storms close Lake Superior from about mid-December until the last of April. The most important cities on Lake Superior are Fort Williams, Port Arthur, Nipigon, Michipicoten, and Sault Ste. Marie, Ontario; Sault Ste. Marie and Marquette, Mich.; Superior and Ashland, Wis.; and Duluth and Two Harbors, Minn. Duluth alone clears more than 38,000,000 tons of freight annually, mainly iron ore and wheat. Superior, like the other Great Lakes, was formed by the action of continental glaciation; it was explored in 1616 by Étienne Brulé.

J. E. F.

**SUPERLATIVE.** *See* GRADATION.

**SUPERMARKET.** *See* MARKETING AND MERCHANDISING (*Retailing*).

**SUPPÉ, FRANZ VON** [zu'pe] (1820-1895), Austrian composer, was born in Spalato (Split), in Dalmatia on April 18, 1820. After serving as conductor in various theatres in Austria, he settled in Vienna in 1861 and remained there until his death. His output as a composer was large, including two grand operas, forty-six operatic pieces, and numerous farces and vaudevilles, as well as a mass and a requiem. He is best known outside his native country for the overtures *Poet and Peasant,* and *Light Cavalry* (1866). Von Suppé died in Vienna, May 21, 1895.

D. L. E.

**SUPPLY AND DEMAND, LAW OF,** a basic part of the economic theory of value and price. It may be stated as follows: if other things remain unchanged, the price of economic goods in a free market will change directly with demand and inversely with supply. It should be emphasized that, according to the law, price is determined by supply and demand. It is improper, therefore, to say that in a given market, at a given time, the demand dropped because the price rose. What is meant is that the quantity taken was less than it would have been if the price had been lower. This fact is shown in the schedule of quantities that could be taken at different prices. Supply and demand change only when there is a change in the quantities that could be purchased or offered at specific prices. Such factors as the time covered, the process of production, and the character of the goods priced, affect the relative importance of demand and supply in determining price. Economists who urge that free operation of the law ensures the best use of resources hold that if sufficient time is allowed, adjustments in the supply and demand for given goods will occur automatically until a price is reached at which the supply brought into the market will exactly equal the quantity that buyers can and will take. M. M. C.

**SUPRARENAL GLANDS.** *See* Adrenal Glands.

**SUPREME COURT, UNITED STATES.** *See* United States of America.

**SURABAYA.** *See* Soerabaja.

**SURAH.** *See* Textile Fabrics (*Silk and Rayon Fabrics*).

**SURAKARTA.** *See* Soerakarta.

**SURAT** [sʊræ′t; su′rət], the chief city of Surat District in Bombay State, India, near the mouth of the Tapti River, about 170 mi. north of the city of Bombay, at 21° 10′ N. lat. and 72° 50′ E. long. Surat was once one of the most important cities in India and by 1500 was a prize sought by European countries. The first Europeans to reach Surat were the Portuguese, who destroyed the city three times in the early sixteenth century and controlled both the port and the coast for nearly 100 years. In 1612 the English routed the Portuguese and captured Surat. They built a factory, established the first trading post of the British East India Company, and made the city the seat of British government in India. Surat prospered and its population is said to have exceeded 800,000. The British, however, obtained the port of Bombay and made it the chief port of the East India Company in 1668, possibly because the harbor at Surat was small, shallow, and heavily silted. Thereafter Surat declined; its population shrank to 80,000 by the middle of the nineteenth century. Industrial development since that time has helped Surat to regain some of its former commercial importance. Manufactures include cotton cloth, striped silk, silk and gold brocades, jari work, sandalwood inlay work, silver objects, and gilt wire. Surat lies on a low, flat plain in a belt of fertile black soil. Cotton, rice, castor beans, and sugar cane are grown. To the west, along the coast, there are salt marshes and mangrove forests; to the east and south is an area of orchards. The annual rainfall is 30 to 50 in., mostly in summer. The railroad from Bombay to Baroda passes through Surat. It is an educational center. Almost a quarter of the Parsees of India live in the city. Pop. 1951, 223,182. R. W. Cr.

**SURESNES** [süre′n], a river port on the Seine, 3 mi. west of Paris at the foot of Mont Valerien. In 1593 Suresnes was the scene of a convention of French deputies, one of the results of which was the conversion of Henry IV to Catholicism, the state religion. Located in the city is an American cemetery for Americans who died in Paris hospitals during World War I. The city's industrial plants include machine shops, printing establishments, and automobile, bicycle, aircraft, textile, chemical, and perfume factories. Pop. 1954, 37,149. W. McE.

**SURETY BONDS.** *See* Insurance (*Fidelity and Surety Bonds*).

**SURFACE,** the surname of three characters in *The School for Scandal* by Richard Brinsley Sheridan: Joseph, Charles, and their uncle, Sir Oliver, who returns from abroad and tests his nephews by observing their behavior before identifying himself. A. H. N.

**SURFACE PHENOMENA,** those physical and chemical phenomena which occur at the areas separating matter of different properties in any two of its three states—solid, liquid, and gaseous. These areas of separation, known as interfaces or boundaries, may be subdivided into mobile or immobile interfaces. Liquid states of matter are involved in the mobile interfaces. Thus, in mobile interfaces, there may be a liquid-gas interface or an interface between two liquids. Correspondingly, there are immobile interfaces between a solid and a gas, a liquid, or another solid.

Surface phenomena become progressively more important as the area of interface between the two states is enlarged. Thus, the more finely divided the liquid or solid that yields the mobile or immobile interface, the more important will the surface phenomena become.

**Brownian Movement of Motion.** In 1827 an English botanist, Dr. Robert Brown, observed a continuous, haphazard, vibratory motion shown by pollen grains suspended in a liquid when viewed under a moderately high-powered microscope. He satisfied himself that the motion was peculiar to finely-divided solid particles in suspension and was not due to such forces as convection or to evaporation, attraction, or repulsion of the particles. It is now known that the motion is due to the impacts of the liquid molecules on the finely-divided particles. These impacts do not cancel each other at every instant and so produce the irregular motion observed. The individual motions cannot be observed, since it has been computed that these occur as often as 100 million million million times a second. Gross displacements of individual particles can be observed, however. The theory of such motion has been worked out by Einstein, Smoluchowski, and others, while the practical experimental observation of such motions and their consequences has been made by J. B. Perrin in France and by T. Svedberg in Uppsala, Sweden. It is now known that the average of the squares of the displacement, $d^2$, is proportional to the time, $t$, and to the absolute temperature, $T$, and is inversely proportional to the radius of the particle $r$, and to the viscosity, $\eta$, of the liquid in which the particles are moving. Included in the equation are the gas constant, $R$, and the so-called Avogadro constant, $N = 6.02 \times 10^{23}$, the number of gas molecules in 22.4 liters of any gas. The equation becomes:

$$d^2 = \frac{RTt}{N 3 \pi r \eta}.$$

The gas constant, $R$, and the Avogadro number, $N$, enter the calculation because the theory of Brownian motion is parallel to that which describes the theory of motion in the particles, or molecules, of any gas, the so-called kinetic theory

of gases. A similar equation describes the time which a gas molecule will take to go from a given distance inside a gas volume to the wall of the containing vessel.

**Diffusion.** The same type of reasoning leads to conclusions as to the rate at which finely divided particles will migrate through a suspension. The rate of this diffusion is proportional to $RT$ and inversely proportional to the Avogadro number $N$ and to the frictional coefficient, $f$, which in the case of a spherical particle is equal to $6\pi r\eta$, where the symbols are the same as in the preceding equation:

$$D = \frac{RT}{Nf} = \frac{RT}{6\pi r\eta} \qquad \text{(for a sphere)}.$$

**Sedimentation.** The more finely divided the particle, the greater the interfacial surface, and the longer will the particle take to settle in any medium. The phenomenon of dust storms in the Dust Bowl is due to slow sedimentation of finely-divided particles of dust in the air. Quicksands and sludges are due to the slow rate of settling of finely-divided solid particles in a liquid medium. Here, the rate of fall, $V$, through the medium is determined by the force of gravity, $g$, acting on a particle the volume of which is $\frac{4}{3}\pi r^3$ and whose density is $d$. It is inversely proportional to the viscosity of the medium in which the particle falls. That is,

$$V = \frac{\frac{4}{3}\pi r^3 dg}{6\pi r\eta} = \frac{2r^2 dg}{9\eta}.$$

The smaller the radius, the slower the velocity of fall. Many milky liquids consist of extremely finely-divided, white particles in suspension in the liquid medium. Although these particles are intrinsically denser than the medium, the velocity of their fall is so slow, because of the smallness of their radius, that years may elapse before sedimentation is achieved. It is known that the stability of these suspensions is due in part to the electrical charges that the individual particles acquire and retain in the solution. Frequently, the suspension may be discharged and sedimentation achieved by changing the electrical charge which the particles carry.

**Surface Tension.** The approximately spherical shape of a small drop of water or quicksilver is due to a surface force or tension present at all liquid surfaces, which acts to

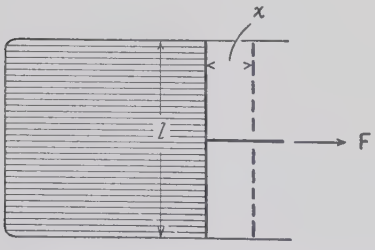



*Fig. 1—LIQUID FILM ENCLOSED IN A WIRE "CYLINDER AND PISTON"*

make the total surface area or interface as small as possible and hence to approach the sphere in shape. The operation of these surface forces can be shown in a variety of ways. If a small film of water is enclosed in a U-shaped wire and closed with another wire acting as a piston, as in Fig. 1, the film can be expanded or contracted by forces exerted on the piston. These changes increase or decrease the area of surface exposed by the water film. If a force $F$ is applied to the piston wire of length $l$, the force $F$ exerted is related to the surface tension by the expression $F = 2l\gamma$ (surface tension). The number 2 comes into the expression because the film has two surfaces. The surface tension is usually represented by the Greek letter $\gamma$, so that $F = 2l\gamma$. If the piston moves a distance $x$, the increase in film area is $2lx$, and so $Fx = 2lx\gamma$. Surface tension therefore may be defined as the force in units (dynes) per unit length of surface of a liquid parallel to the surface. The connection with the contractile force in a liquid arises because the molecules within the body of a liquid are acted upon equally in all directions by forces exerted by other molecules. The molecules at the surface of the liquid, however, are acted upon more strongly on the liquid side than on the vapor side. The work that must therefore be done in pulling new molecules to the surface by increasing the surface area is measured by the work done in creating the increased surface, $2lx\gamma$.

Surface tension can be measured indirectly by measuring the mass of a drop of liquid which falls from an orifice.

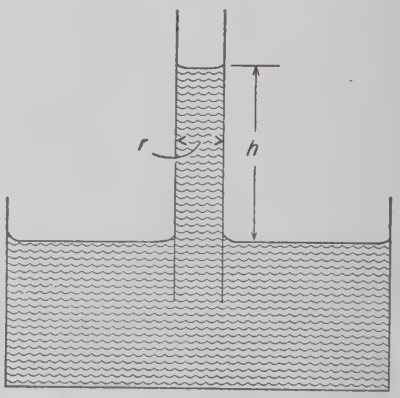



*Fig. 2—RISE OF LIQUID IN A CAPILLARY TUBE*

It may also be measured by the rise of liquid, $h$, in a narrow or capillary tube. In Fig. 2, the surface tension, $\gamma$, operates at the circumference, $2\pi r$, of the tube of radius $r$. The force of surface tension is balanced by the pressure due to the column of water, of volume $\pi r^2 h$, of density $d$, acted on by gravity, $g$. Hence:

$$2\pi r\gamma = \pi r^2\, hdg, \text{ and}$$
$$\gamma = \tfrac{1}{2}\, rhdg$$

In a tube of known radius $r$, the surface tension is therefore measured by the height of rise and the density of the liquid.

Surface tension or, more precisely, interfacial tension, is also manifested between two liquids. Thus, drops of oil form in water; whether they rise or fall depends on the relative densities of the two liquids. The surface tension is measurable by the same methods used with liquids in air, for example, by measuring the mass of drops formed by one liquid at an orifice in another liquid.

**Surface Films.** Surface forces, or interfacial forces, are responsible for the spreading of oil films on water, as in the case of castor oil. They also are responsible for the behavior of certain oils, principally pure mineral oils, which do not spread on water but form lenses on it. Chemical interactions are responsible for the different behavior: oils that spread cause a lowering of surface tension, whereas nonspreading oils prefer close association with themselves rather than with water molecules. The researches of Lord Rayleigh, Miss Pockels, Irving Langmuir, W. D. Harkins, N. K. Adam, and others led to the conclusion that oils which spread on water form a single layer (a monolayer) of oil molecules on the surface. The molecules are arranged in a definite pattern on the surface. The water-soluble or polar portion of each molecule is held down at the water surface. The water-insoluble portion of each molecule tries to get away from the surface. Nonspreading oils have no polar or water-soluble portion. They therefore lie as a lens on the water surface.

An oil film on water may be "gaseous" or "condensed."

Gaseous films occur when each oil molecule is separate from its neighbors on the surface. In condensed films, the oil molecules are crowded compactly together. These two possibilities are shown in Fig. 3.

The gaseous film acts like a two-dimensional gas with a definite surface pressure $F$. The product of the force $F$ and the area $A$ occupied by the film is constant at constant temperature, $FA = kT$. If the film is compressed sufficiently, the individual oil molecules become more and more crowded on the surface until finally they become close-packed. At this

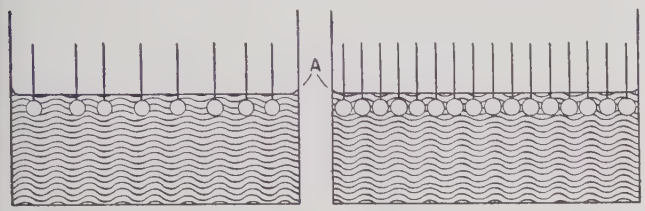



*Fig. 3—PHENOMENA OF AN OIL FILM ON WATER*
*(a) "Gaseous" film; (b) "Condensed" film*
*O = polar end of each oil molecule;*
*— = nonpolar end of each oil molecule; (A) Surface of water*

point, the force $F$ rises steeply. The area at the point of steep rise is then the cross-sectional area of the molecule in its position of orientation on the surface. Langmuir was thus able to measure the cross section of a variety of molecules and, hence, to calculate from the volume what the length of each molecule must be. His results were verified later by X-ray measurements.

Condensed films may be "liquid" or "solid." Such films can be studied when spread as monolayers on water, with cylinder oil as a multilayer boundary showing interference colors and thus indicating the area of spread. Solid films so formed show a serrated edge and can be torn apart by a drop of cylinder oil placed in the center of the film. Liquid films have a circular outline, and the cylinder oil added to the film center will spread circularly (*see* Fig. 4).

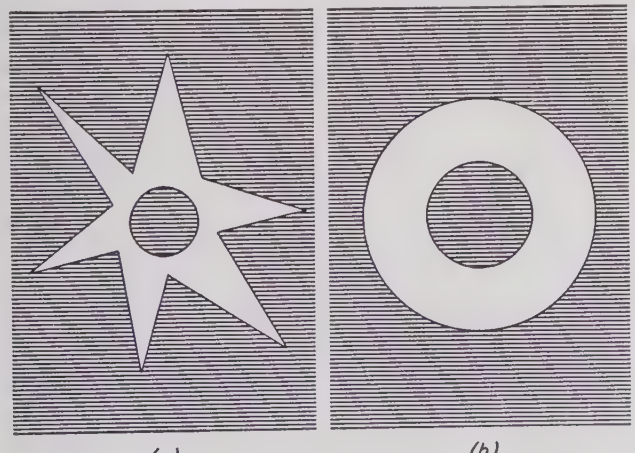



*Fig. 4—PHENOMENA OF A CONDENSED FILM*
*(a) "Solid" condensed film; (b) "Liquid" condensed film*
*(Shaded areas are cylinder oil.)*

**Multilayer or Built-up Films; Lubricants.** In 1935, Katharine Blodgett developed a method of building up successive monolayers on a surface by dipping polished metal sheets into, and withdrawing them from, a monolayer of the material spread on water. The pattern of build-up is shown in Fig. 5. The properties of lubricating oils are, in part, dependent on the capacity of bearing surfaces to abstract from the lubricant materials which build up on the surfaces of the moving parts, and so decrease the friction that would otherwise obtain if such films were not present.

Antireflecting coatings on glass are produced by the formation of built-up films on the glass surface. These films may consist of barium stearate (Blodgett) or of fluorides of magnesium or calcium (C. H. Cartwright). Etching off the oxide surface of glass is an alternative method of producing the nonreflecting surfaces. The individual lens elements of lenses for cameras, motion-picture cameras, and projection apparatus are thus covered with built-up

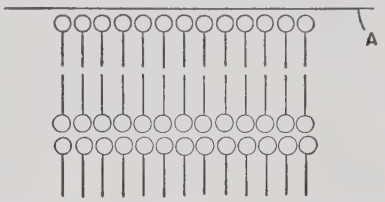



*Fig. 5—REPEATING PATTERN OF ORIENTED OIL FILM ON METAL SURFACE*
*(A) Edge of metal surface*

films to increase the light transmission. An increase in illumination as high as 30 to 40 per cent can be secured by this method.

**Adsorption; Chemisorption.** Solid surfaces have also the capacity to condense or adsorb gases and vapors on the surfaces (that is, to make them adhere in a thin layer) by reason of the residual forces in such surfaces; moreover, they have the capacity to adsorb the constituents of a solution from such solutions. These surface forces have important practical applications. Substances with extended surfaces, such as charcoal and silica gel, can be used for clarifying solutions by adsorbing the coloring matter in the solutions; for dehumidifying or drying air or vapors by adsorbing water vapor; in solvent recovery by adsorbing vapors from low concentrations of these in gases; and in gas masks to adsorb toxic gases, and so to remove them from contaminated air. A wide variety of chemical substances, notably nickel, platinum, iron, cobalt, silver, copper, zinc oxide, chromium oxide, and other oxide mixtures, can be used as catalysts to promote the speed of chemical reactions. Such substances can be brought into a condition of extended surface and can then bind gases and vapors to their surfaces in chemically active form by processes which are known by the term chemisorption.

Adsorption at surfaces can be caused by physical or by chemical forces. Physical adsorption is analogous to liquefaction and involves similar forces. Heat is generated by the adsorption process. In physical adsorption, the heat is comparable to the heat of liquefaction. At low concentrations of vapor, the layer of adsorbed material does not normally exceed a monolayer. Close to the condensation point, multilayers will form; and if there are pores, these will fill with liquid. In chemisorption, the binding to the surface is much closer, and involves much stronger and quite specific chemical forces: the heats developed may be one or two orders of magnitude greater than those involved in physical adsorption; the adsorbed layer is never more than one layer thick; and, in the process, the substance adsorbed may undergo a considerable structural change. Thus, hydrogen, the molecules of which contain two atoms, $H_2$, is completely dissociated at many metal surfaces and each hydrogen atom is separately bound to a surface metal atom, Me-H. Such hydrogen atoms, so bound, are in general more reactive than hydrogen molecules and so may join with other molecules more readily.

The adsorbent surface thus behaves as a catalyst or accelerator of chemical reaction.

Because adsorption is always accompanied by liberation of heat, the extent of adsorption at a given concentration of gas or vapor decreases with increasing temperature. Contrariwise, it increases with decreasing temperature. Charcoal, at liquid-air temperatures, has an enormous capacity to bind gases to its surface by adsorption. Thus, it may be used to remove practically all the gas molecules from a given container, so producing high vacuums in filament lamps, vacuum tubes, or thermos vessels. Chemisorption may be highly dependent on temperature, not occurring at all at low temperatures, at which only physical adsorption then occurs. Chemisorption sets in as the temperature is raised. At sufficiently high temperatures, the capacity of the surface to hold the gas, even by chemical forces, decreases; and, so, in such temperature ranges, the surface becomes progressively barer with increase of temperature.

Adsorption varies directly with the pressure. At low pressures of gas and vapor it is proportional to the gas or vapor pressure. At high pressures, the adsorption becomes independent of the pressure because the surface is saturated. In solutions, the concentration of the substance adsorbed plays the same role as pressure in gaseous systems. At low concentrations, adsorption is proportional to the concentration. At high concentrations, the surface becomes saturated, and adsorption is constant and independent of concentration.

In the case of most adsorbents, the surface is not uniform. For these, it is found that the adsorption, $x$, is proportional to a fractional power of the pressure, $p$, or the concentration, $c$. Thus:

$$x = kp^{1/n} \quad , \quad \text{or} \quad x = k^1 c^{1/n} \quad .$$

The concentration in the surface layer of a solution can also be related to the interfacial tension of the solution by a mathematical deduction due to Willard Gibbs. There is an excess of solute in the surface of any solution when that solute decreases the surface tension. When the solute increases the surface tension of a solvent, there will be less solute in the surface than in the body of the solution.

**Surface Energy of Small Particles.** As particles are subdivided, the area increases, as does the free energy of the surface. As a consequence, finely-divided particles have a larger solubility and a higher vapor pressure than larger particles, accounting for the change in particle size of precipitated powders on standing in solutions. The coarser particles grow at the expense of the finer particles, which tend to disappear.

The same phenomenon occurs in fogs and clouds. The finer particles evaporate and condense on the coarser particles. In this way, clouds change into raindrops. A similar process is responsible for the conversion of clouds to snowflakes. These factors are basic to the methods proposed for producing rain or snowfall by "seeding" clouds with dry ice, silver chloride, or even fine water sprays.

**Smokes and Fogs.** The rapid combustion of a wide variety of materials in a large excess of air produces smokes that consist of finely-divided particles in the gas. The rapid expansion of high-boiling liquids into large volumes of air will produce stable fogs of great screening power. Thus, Langmuir and Schaefer produced efficient wartime fog screens by evaporating high-boiling oils through nozzles at supersonic velocities into air. The procedure produced fog particles of extremely small dimensions and of corresponding stability with which wide areas could be screened much more effectively than with the most efficient smoke screens. Fogs and smokes of this maximum stability have also the capacity to pass through filters with minimum retention. It is possible, therefore, to produce toxic smokes of such a small particle size that they will pass through the ordinary type of gas-mask canister without being removed, necessitating the development of special filters.

**Electrical Effects on Fine Particles.** The effect of charged particles in promoting the agglomeration of fine particles is well known to physicists who use the Wilson cloud chamber. In this chamber, supersaturated water vapor is condensed to fog tracks along the path of electrons, or electrically-charged particles of matter or ions are introduced into the cloud chamber by the ionizing influence of alpha particles, protons, cosmic rays, and the like. Sir Oliver Lodge made early experiments to precipitate fog and to dissipate smoke by charging the air over cities electrically at high voltages. About 1911, F. G. Cottrell developed the principle of electrical precipitation of suspended particles to such a point that commercial application became feasible, and it was applied to industrial smokes. Precipitation occurs readily on flat surfaces if placed opposite points charged to a high potential of 20,000 to 30,000 volts. The air space between surface and points becomes charged and the charge is communicated to particles passing through the air space. So charged, the dust particles travel to the flat surface, and there they adhere.

In liquid systems, small suspended particles can acquire electrical charges by adsorbing on their surfaces ions present in the system from dissolved salts. These charged particles will move under the influence of an electric field, in a fashion dependent on the charge they carry. This migration under an applied field is known as cataphoresis. This principle has been used to build up structures from fine liquid or solid particles. Thus, finely-divided rubber latex can be made to migrate to a surface and thus build up rubber articles in the form of thin rubber coats on a prepared mold. Rubber gloves can be made thus. Conversely, when a liquid is streamed through a porous diaphragm composed of such fine particles, an electrical current can result from the streaming process. This is known as electrical endosmose.

The charge carried by a finely-divided particle in a solution containing ions is dependent on whether an excess of positive or negative ions is adsorbed under the given conditions. As a simple illustration, a particle of silver chloride is composed of silver ions and chloride ions, and these are found in approximately equal numbers on the crystal faces. If the particle is placed in a solution of a silver salt, an excess of silver ions will be adsorbed on top of the chloride ions in the surface; the particle will show a net positive charge. If the particle is placed in a solution of a soluble chloride, say sodium chloride, the chloride ions will be adsorbed in excess on the silver ions of the particle surface; the net charge on the particle will now be negative. As long as the particles are all charged positively or all charged negatively, they tend to repel each other; coalescence does not occur. When, however, there are both positively and negatively charged units present, these will neutralize each other and cause coagulation or precipitation. Thus, if silver nitrate solution is added to a solution of a chloride, drop by drop, or if the addition is reversed, chloride being added to nitrate, in each case, a milky-white liquid of finely-divided silver chloride, carrying one or the other charge, is formed. However, when a certain quantity of either reagent has been added to the solution, in each case the charge will become balanced, positive and negative; coagulation will occur as a stringy precipitate, with the supernatant liquid no longer milky but clear.

**Gels and Jellies.** Many substances precipitate from solutions as fibrous structures that form clusters or networks. Many of these structures adsorb water strongly. A small amount of precipitate is thus able to immobilize a large amount of water. The solids so constructed are known as gels or jellies. Other liquids than water can be so immobilized by adsorption on suitable network precipitates. In "canned heat" for example, alcohol is available in a solidified network or "brush-heap" structure.

**Emulsions and Foams.** Two immiscible liquids can be caused to form a quasi-hemogeneous liquid system of good stability, known as an emulsion. In reality, one liquid is finely dispersed in the other, which forms the continuous phase. Emulsions may be of the oil-in-water type or the water-in-oil type, depending on the conditions. The stability of such emulsions is in large measure dependent on stabilizers which concentrate at the interface between the oil and water. These stabilizers will normally be molecules, part of the structure of which is soluble in the oil, and the other part soluble in water; thus, they act as links between the two liquids at the interfaces.

Foams form on all solutions that show an appreciable lowering of the surface tension of the solution. They are produced by shaking the solution. The stability of such foams will vary considerably. To get a stable foam, the surface film must be of itself viscous or be made so by adding suitable agents to the interface, for example, fine powders. This surface phenomenon is of importance in cleansing and detergence. The solid particles constituting the dirt are so abstracted from the object being cleansed. Carbon dioxide foams or froths used for fighting fires are formed from sodium bicarbonate and metallic salts: for example, aluminum sulphate.

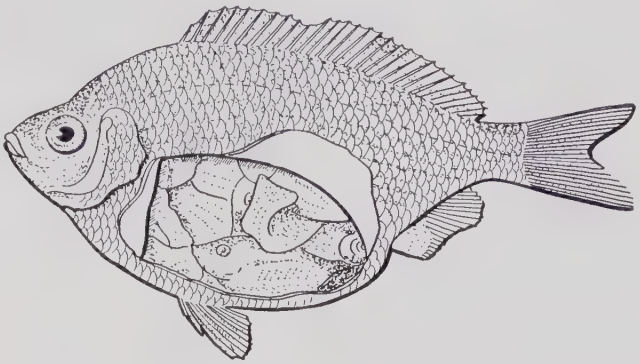
The adsorption of solids by liquids or by liquid films in foams is an important aspect of the industry of ore flotation and concentration. This is dependent on the development of agents that dissolve in the water and, at the same time, wet the solid surfaces to cause these to move with the liquid used, or to pass up into the foams that may be formed. The wetting agents used are specific for the mineral to be concentrated and are determined by the chemical nature of the mineral surface. *See also* Colloid Chemistry; Kinetic Theory and Statistical Mechanics; Lubrication; Precipitation, Electrical; Solids and Liquids, Theory of; Solutions, Chemical. H. S. T.

**SURFACE TENSION.** *See* Colloid Chemistry; Surface Phenomena.

**SURFBIRD,** a 10 in. wading bird, *Aphriza virgata,* allied to the turnstones. It breeds on high mountains of south central Alaska and winters on the Pacific coast of the Americas from Oregon to the Strait of Magellan. In winter it is brownish gray above and grayish white below. At all seasons it has a band of white along the extended wing and a broad terminal black band on the white tail. It may be seen on the coasts of the western United States, associated with turnstones, at rocky promontories, where it feeds on the barnacles and small mussels exposed at low tide. H. G. De.

**SURF CASTING.** *See* Fishing.

**SURF FISH,** small perchlike fishes of the family Embiotocidae, native to Pacific coastal areas, which give birth to rather large living young. The body is long and oval in shape and much compressed, ranging in length from 5 to 18 in. Some have red or blue stripes but most are silvery. Three species are found in Japan and the remaining 18 species are found only in California. They live in shallow coastal waters in bays or in the surf of sandy or rocky beaches. However, one lives in rather deep water and another, *Hysterocarpus traski,* lives in fresh-water streams of northern California. Mating occurs in late winter or early



*Surf fish,* Rhacochilus toxotes, *partially dissected to show the young*

summer and the living spermatozoa are carried in the female until late fall or early winter when the eggs are actually fertilized. The 8 to 18 or more young are retained in bags of fine tissue which are part of a modified oviduct and are bathed in nourishing body fluid. They are born the following spring or summer when about one inch long. Although esteemed by many anglers, surf fish are of minor commercial importance. E. C. R.

**SURGEONFISH, DOCTORFISH,** or **TANG,** a family, the Acanthuridae, of small-scaled compressed fishes found about coral reefs and tide pools in tropical seas. They are further distinguished by a sharp movable spine on each side of the tail base. These spines, which give the fish its common name, turn forward and into a sheath. When the fish is disturbed, the spines are erected, forming a dangerous weapon especially if grasped by the tail. About eighty species are known. Most of them are a soft gray-brown but some are bright blue and others have scarlet on the tail. Food consists largely of vegetable matter. The blue tang, *Acanthurus coeruleus,* of the West Indies area is common about Florida and sometimes strays northward to Cape Cod. The young are yellow and change to the blue phase when 5 or 6 in. long. The maximum length is about 1 ft. E. C. R.

**SURGERY,** that branch of medicine that treats diseases, disorders, malformations, and injuries wholly or partially by operative procedures. Surgery was practiced in very early times and prehistoric human remains indicate that surgery had attained a remarkable degree of competence. In historic times, and until the mid-eighteenth century, the surgeon was held in little esteem. Operations of considerable complexity were performed in Greece, Rome, India, and elsewhere in the ancient world, but, in general, surgery was considered an inferior branch of medicine. With the decline of learning in the Middle Ages the practice of surgery was delegated to barbers and wandering quacks. As Haggard points out, the reasons for the failure of surgery to develop fully were fourfold: a lack of anesthesia, an ignorance of the nature and control of infection, an ignorance of anatomy, and an inability to control hemorrhage. All but the most superficial surgery thus remained hazardous until comparatively

recent times. From the time of Vesalius (1514-1564), however, anatomical knowledge made great progress, and in the nineteenth century the development of anesthesis and the progress made in the field of antisepsis and asepsis based on the work of Pasteur, Lister, and others made possible the development of modern surgery. The subsequent use of X-rays in diagnosis and the discovery of increasingly effective controls for infection, coupled with great advances in surgical techniques, have brought about a remarkable decrease in surgical mortality, and the number of lives saved or prolonged by modern surgery is incalculable.

Modern surgery is divided into two types, namely, major and minor. This division is indicated by the extent of the procedure and may be illustrated as follows: incision of boils or carbuncles and suturing of cuts are classified as minor surgery; herniotomy and appendectomy are classed as major operations. Most minor operations are of short duration and are generally confined to the surface. Major operations have to do with the more vital organs and as a rule are of larger duration although they may vary greatly in the length of time required to perform the work. For example, an appendectomy may be performed sometimes in fifteen minutes, whereas the removal of a stomach requires from two to three hours and the removal of a pancreas may take as long as nine hours.

The technical name of an operation has a double meaning. The first part of the word applies to the organ and the last part to the procedure. For example, gastrectomy means removal of the stomach—gastric meaning stomach, and ectomy meaning removal. There are three such endings used in connection with operations on the organs of the body: ectomy, meaning removal; ostomy, to open and leave open; and otomy, to open and close; for example, gastrectomy, gastrostomy, and gastrotomy.

The medical student is both interested and astounded by the things that may be done to the human anatomy with little or no ill effect. He is convinced that we are fearfully and wonderfully made for the following reasons: some organs can be completely removed; some can be partially removed; and others can be short-circuited. Such operations are possible because nature has provided us with a great excess of certain types of tissue. We have eight times as much kidney tissue, seven times as much lung tissue, and ten times as much thyroid tissue as we need. Short-circuiting operations are made possible because other organs will take over the function of the ones that are short-circuited. For example, the ureters, which are the tubes that carry urine from the kidneys down to the bladder, can be transplanted into the large intestine and the bladder omitted. The liquid part is either absorbed or passed in the stool and the patient can live comfortably with no inconvenience. The large intestine can be removed and the small bowel allowed to open on the abdominal wall. The contents of this part of the intestine are ordinarily liquid. When so placed the contents become solid and the small intestine takes on the function of the large.

The following organs can be completely removed with no ill effect to the patient: the appendix, gall bladder, colon, stomach, spleen, and tonsils. Other organs can be partially removed, such as the brain, kidneys, thyroid, liver, pancreas, and lungs. Thyroid and pancreas can be completely removed with no ill effect to the patient, provided he is given substitution therapy.

General surgery is divided into subgroups, such as traumatic and nontraumatic surgery. The traumatic deals with conditions caused by an injury requiring surgery. The nontraumatic is concerned with infections, tumors, malformations and ulcers. General surgery can also be subdivided into septic and aseptic surgery, septic meaning due to an infection, and aseptic, not infected. An example of septic surgery is gas gangrene. An example of aseptic surgery is a thyroidectomy.

The more common bacteria encountered in surgery are the *Streptococci, Staphylococci,* and the bacteria found in the large intestine which are *Bacillus coli.* There are many different subgroups of these three. There are two other bacteria encountered, mainly in war surgery, which are known as the tetanus bacillus and the *Bacillus welchii.* The latter causes gas gangrene. The infections caused by the many strains of streptococci and staphylococci respond to the sulpha drugs and penicillin. The groups of bacteria found in the intestinal tract respond to treatment with streptomycin. This chemotherapy has made it possible to perform operations with much greater safety and has greatly decreased postoperative complications. It has become a source of encouragement and comfort to both the surgeon and the patient.

## OPERATIVE TECHNIQUE

**Surgical Instruments.** The modern operating room is equipped with many simple and complicated instruments and apparatuses. There are certain basic ones required for any operation, such as hemostats (clamps required in grasping blood vessels), scalpels (knives), needles, needle holders, sponge sticks, thumb forceps, scissors, and various retractors. Each type of major surgery requires many special instruments as well as the basic ones. For instance, it would be impossible to perform a spinal fusion with the same instruments that are required for the removal of a gall bladder. These special instruments are so shaped and designed as to facilitate the surgeon's technique, thereby making the procedure easier for both the surgeon and the patient. Special lights are necessary so that the surgeon can see what he is doing. They must be bright, adjustable, and must not throw shadows.

**Preparation of the Skin.** The first and most important step is the proper cleansing of the skin. All hair-bearing areas should be carefully shaved. They should then be cleansed with soap and water and dried with ether. Antiseptic solutions such as iodine are then applied. At best only the surface bacteria are inactivated by antiseptics and not the ones in the glands or hair follicles of the skin. Consequently, the cleansing with soap and water is the most important single procedure, since this cleanses and removes most of the bacteria on the surface.

**Types of Incisions.** Incisions can be made with a knife or with an electrocautery. The advantages of the latter are that it reduces bleeding and, if dealing with cancer, closes off the lymphatics and reduces the spread of the tumor cells.

**Locations.** The choice of incision is influenced by its proximity to the organ upon which the operation is to be performed and also by the structures through which the surgeon must go to reach the organ which is to be removed. The surgeon must avoid cutting vital structures. For instance, the easiest approach to the hip joint would be to make an incision in the groin and go directly through the tissues encountered, but these tissues would include the main blood vessel to the leg and an important nerve which serves the thigh. Consequently, such an incision would be impractical. Most surgeons prefer muscle-separating operations to muscle-cutting ones. An example of muscle-separation is the McBurney incision for an appendectomy. The muscle-cutting incision cuts transversely across the muscle fibers and is always employed in the removal of the spleen. These incisions are more difficult to close. Moreover,

if a rupture should occur in such a wound, it is most difficult to repair.

**Hemostasis.** This concerns the control of bleeding. It is most important for the patient and also for the surgeon. Blood loss is the most common cause of shock. Patients can be operated on for eight or ten hours without showing signs of shock provided no blood is lost. In most cases the amount of blood lost should be very small if the surgeon will take the time and trouble to clamp and then tie off all bleeders with a ligature. It is important to have a dry operating field so that the surgeon can see the anatomical structures. Sometimes it is impossible to avoid a certain amount of blood loss. In these cases the operative field is kept dry by sponging or absorbing the blood with gauze pads. Suction is also used for the same purpose.

**Retraction.** This is the separation of the incision with instruments called retractors. All tissues, especially muscles, become approximated if left alone. It is necessary that the surgeon see clearly what he is doing; consequently, retraction of the wound is extremely important and the patient must be properly relaxed with an anesthetic to accomplish this act. There are many different retractors in use. Some are named according to their shape, as the rake retractor or right-angle retractor, others according to their purpose, as the self-retaining retractor, and others are named by their designer. The retraction is usually done by an assistant.

**Sutures.** After having anesthetized the patient, prepared the skin, made the incision, controlled the bleeding, and removed the pathology, the defect is repaired by sutures.

*Suture Material.* There are three types of suture, namely absorbable, nonabsorbable, and living sutures. The absorbable sutures are plain and chromic catgut. The term catgut is a misnomer for they are actually made from sheep intestines. Sutures vary greatly in size and strength. The chromic sutures are treated chemically and are more resistant to tissue absorption. They remain in the tissues from 10 to 40 days. Plain catgut is absorbed more rapidly. Catgut is a tissue irritant and it is this irritation which causes a tissue reaction resulting in ultimate absorption. There are four main types of nonabsorbable sutures, namely, silk, cotton, silver wire, and vitallium wire. Even though these sutures are not absorbed they remain in the tissues for years, causing no discomfort. These sutures are used only in clean wounds which have weak tissues, as in a hernia. They remain in place indefinitely. Living sutures, which are usually obtained from a firm layer of tissue which surrounds the thigh muscles, the fascia lata, become part of the tissue in which they are placed. Blood vessels grow into them from the surrounding tissues and they become part of the living tissues.

*Needles.* Sutures are placed in the tissues with needles. These needles vary greatly in size depending on the size of the suture material used and the delicacy of the tissues through which they are passed. For instance, very fine ones are used in eye operations and large ones for the approximation of fat layers in wounds. Needles have round edges and cutting edges. The latter are used in tough tissues such as skin. The cutting edges extend back from the point about one third of the length of the needle and as it passes through the tissues it cuts its way, thus facilitating its passing. The round edge needles are used in softer tissues as muscles and fat. Needles may be straight or curved. The curved may have a full curve, shaped like a circle, or a half curve. The straight needles are held in the fingers, whereas the curved type is used with a needleholder which helps to control it and enables the surgeon to force it through the tissues.

**Drains and Dressing.** Drains are generally of some type of rubber tubing which can be removed easily without sticking to the tissues and causing too much pain. They are used in wounds where pus is encountered, as in an abdominal abscess, or where a collection of serum may form after the incision is closed. A fairly large dressing is applied, in the form of sterile gauze pads, to cover the wound, and this is held in place with adhesive.

**Postoperative Care.** Patients are given from one sixth to one quarter of a grain of morphine or its derivatives every four hours, if necessary, to control the pain. The pain usually subsides by the second or third day and can be controlled then by milder sedatives. The skin sutures or clips are removed generally between the seventh and the ninth day after operation.

**Wound Healing.** This begins very quickly and the average wound is quite firm by the twelfth to the fourteenth day. Healing is retarded by infection, collection of serum in wounds, lack of vitamin C, and low protein content in the blood. Infections retard or may even prevent wound healing; this may be easily controlled by such drugs as sulphadiazine, penicillin, or streptomycin. Experiments have proved that vitamins, especially vitamin C, and blood proteins hasten the process of wound healing. Anemia does not in itself affect wound healing.

**Surgical Risks.** Surgical risks affect the chance the patient has of recovering from the surgical procedure. They are not related to the end results except insofar as the patient's immediate chances of withstanding the operation are concerned. Such risks are classified as good, poor, and bad. They are influenced by infection as peritonitis, diseased kidneys (nephritis), diseased lungs (tuberculosis), conditions of the heart (as coronary occlusion, valvular disease, and decompensation of the heart), imbalances in blood chemistries (as hypoproteinemia, decreased amount of protein in the blood), dehydration, anemia, and avitaminosis. Age and weight influence surgical risks to a minor degree. Young babies withstand intestinal resections very poorly. Old people, however, withstand surgery very well provided their condition is not jeopardized by any of the above complications. Adipose (fat) patients are not as good surgical risks as thin patients due to the fact that they require more anesthesia, and the surgical procedures are more difficult to perform because of the poor exposure and the thick layers of tissue through which the surgeon has to work. Fat gets on the surgeon's gloves, making steps such as placing and tying ligatures more difficult. Many of the conditions mentioned previously, as tuberculosis of the lungs and cardiac conditions, can be partly overcome by the proper use of anesthesias. *See also* ANESTHESIA. W. H. B.

## NOSE AND THROAT SURGERY

Although many conditions of the nose and throat are effectively and adequately treated by purely medical means, some diseases of this area demand operations for their proper relief. Operations on the nose include those performed for cosmetic reasons, for the improvement of breathing space, for the proper drainage of infections in the sinuses, and for the removal of tumors and foreign bodies. In the throat, operations are needed for the removal of infected tonsils and adenoids, and of tumors, both benign and malignant. Operations are also needed for the relief of mechanical asphyxia in cases of obstruction by inflammation, tumors, or foreign bodies.

**Plastic Repairs.** One of man's earliest known reasons for consulting the surgeon was the desire to change the shape of his nose. The misshapen nose may be cosmetically un-

desirable without seriously hampering the respiratory function, but it may be of great medical importance by being psychologically harmful.

One of the chief difficulties of nasal plastic surgery is the fact that radical changes have to be made in the deeper structures without scarring the skin. Extensive operations can be performed on the bridge of the nose by incisions made in the lining, instruments being inserted through the nostrils. Rasps and files are introduced in this way to lower a hump in the bone. Pieces of cartilage taken from the ribs can be grafted into the bridge through this approach. Molds are made of dental plaster or soft metal to hold the nose in the desired form while it heals. Severe nasal deformities require external surgery. For example, if the nose is very small or absent, it can be constructed by bone, cartilage, and skin grafts or by the application of artificial appliances to simulate the shape of the natural nose. Such extreme deformities may be present at birth or may result from accidental or war injury.

**Repairs of Sinuses.** Internal nasal operations are done either for the relief of obstruction or for improvement in the drainage of the sinuses. When the natural drainage of a sinus is prevented by an obstruction in its tiny opening or in the nose, painful and even dangerous sinus disease may result. Such obstruction could be brought about by deformity of the inner structure of the nose, from improper development, or from injury, or by swelling associated with infection, or by the presence of polyps, tumors, or foreign bodies. The treatment of these conditions must often be surgical. The operations are performed by means of long instruments inserted through the nostrils.

**Radical Operations.** Tumors, cancer, or severe chronic infection may call for radical operations, such as the removal of the entire lining of one or more sinuses. In these cases, the surgical approach is made either from the mouth into a sinus, or else through the skin of the face. Scars carefully placed in the natural creases of the face may go almost unnoticed. A radical operation of the frontal sinuses, which are situated just above the eyes, may result in the depression of the forehead. Various methods of plastic reconstruction are used, such as bone or cartilage grafts, or of artificial supports.

**Tonsils and Adenoids.** Throat operations are complicated by the fact that several vital structures are found in the neck, including the food and air passages and some important vessels and nerves. Damage to these structures may have serious consequences. Above all, the airway to the lungs must be kept open at all costs, a factor which requires constant vigilance during an operation so as to avoid obstruction by pressure, mucus, or blood. In tonsilectomy and adenoidectomy, the patient is placed in a head-low position so that blood and saliva are kept in the upper throat by gravity, and constant cleansing, effected by use of a suction pump, is maintained during the operation. The tonsils are accessible with long instruments passed through the mouth. The adenoids are located on a level higher than the soft palate. They are removed with cutting instruments angulated to reach upward.

**Cancer of Throat.** Cancer of the throat is a disease challenging the ingenuity of both surgeon and patient. In many cases it is necessary to remove the entire larynx or "voice box," the patient breathing through a permanent opening made in the lower part of the front of the neck.

**Tracheotomy.** One of the most alarming conditions ever to confront the physician is obstruction of the throat by swelling, tumor, or foreign bodies. When the obstruction is complete, it is with desperate urgency that the patient must be provided with an airway to the lungs or death will supervene in a few minutes. An incision is made in the front of the neck. The trachea, or "wind pipe" is opened, and a silver tube is inserted to admit air. This operation, known as tracheotomy, is usually performed before the obstruction becomes complete, since the majority of such cases are not abrupt in onset.

**Foreign Bodies.** Foreign bodies in the air and food passages are usually removed by the insertion of illuminated metal tubes, such as the bronchoscope and esophagoscope, through the mouth into the passageway involved. Foreign bodies may be such objects as fish bones, chicken bones, peanuts, straight pins, safety pins, needles, tacks, buttons, or coins. Special long-handled forceps have been designed for grasping different types of foreign bodies. For example, there are instruments for closing a safety pin while it is still down in the throat. The removal of foreign bodies is aided by x-ray films or by the bi-plane fluoroscope. *See also* EAR (*Ear Surgery*); EYE (*Eye Surgery*). R. C. M.

## THORACIC SURGERY

**Surgery of the Lungs.** Most surgery of the lungs is undertaken in the treatment of tuberculosis. One of the main factors responsible for the lowering of tuberculosis mortality has been the pneumothorax operation. By this procedure air is injected into the pleural cavity surrounding the lung; the lung is thus made to collapse since the negative pressure in the pleural cavity which prevents it from doing so is released, and in this quiescent state the tuberculous lesions in the lung are enabled to heal more effectively. In the event that tuberculous adhesions prevent the collapse of the lung by a pneumothorax, a more radical operation, thoracoplasty, may be undertaken. This involves the removal of the ribs covering the affected portions of the lung and produces a permanent collapse of the chest wall over the diseased area. This collapse of the lung can also be effected by a paralysis of the portion of the diaphragm under the affected lung, or, in the case of adhesions, an operation, intrapleural pneumolysis, has been developed by which the adhesions may be divided by means of a small cautery. Thoracoplasty is used in cases where the lung is so diseased that even a long period of collapse would not serve to restore the function of the lung tissue.

The most radical operation on the lung is the resection or removal of the diseased areas. This operation is indicated in cases of cancer of the lung, in cases of tuberculosis where the lung tissue has been damaged beyond recovery, in lung abscesses, in cases involving gangrene, or in cases of bronchiectasis, where portions of the bronchi have become distended and inelastic and therefore cannot be drained of infection by the normal process of coughing.

**Surgery of the Pleura.** Empyema, or pus, in the pleural cavity was well recognized by Hippocrates, who recognized the good results of draining such an abscess. At the present time early empyema is best aspirated with a syringe and needle until it becomes thick, after which it becomes necessary to drain it. Chronic empyema heals with difficulty. The cure of tuberculous empyema is to bring the two surfaces of pleura together and allow the space to be obliterated.

**Surgery of the Heart.** The hazards of performing surgery on the heart did not prevent early investigators from undertaking it. In 1897 Rehn first successfully sutured a stab wound of the heart in man, and other early surgery included decortication for a condition in which the heart is encased and constricted by a thick plaque of fibrous tissue. Another early example of heart surgery involved an operation

on the heart valves to overcome the narrowing that occurred when the valve had been affected by disease.

Various congenital heart defects in children have been corrected by surgery. In the condition known as patent ductus arteriosus, the blood circulation of the fetus transporting blood from the right side of the heart to the general circulation without traversing the lung tends to persist instead of changing normally at birth, when the ductus arteriosus regularly tends to close. For such cases, an operation has been developed to tie off this vessel. In the case of coarctation, a congenital narrowing of the aorta, an operation is possible to resect the narrowed portion and establish a normal flow of blood. Another congenital defect of the heart is pulmonary stenosis, where the pulmonic valve connecting the right ventricle with the pulmonary artery is narrowed and prevents or slows the flow of blood to the lungs; in addition a communication between the ventricles shunts the blood from the right to the left side and into the general circulation without going through the lungs. Such a condition has been ameliorated by surgically establishing a communication between the general circulation and the pulmonary artery. This operation does not completely rectify the inadequacy, but it enables a child to lead a fairly normal existence.

Further operations on the heart are limited by the fact that the supply of aerated blood to the brain must not be cut off for more than five to seven minutes. For this reason attempts have been made to aerate the blood outside of the body and return it to the head, thus permitting more extensive surgery without the heart having to fulfill its function of supplying the brain with blood. In spite of this time limitation, however, a certain amount of intracardiac work has been performed, such as attempts to close patent interventricular septa and direct surgery on the mitral valve. Experimental operations in cases of coronary thrombosis, where the blood supply nourishing the heart itself is reduced, have also been attempted to replenish the blood supply of the heart from adjacent tissues.

**Other Thoracic Surgery.** In cases where the esophagus must be removed, a technique has been developed whereby the stomach is brought up into the chest, care being taken to preserve its blood supply, and to connect it to the upper end of the esophagus. Surgical treatment is also possible for cases of diaphragmatic hernia or injury, and operations on the sympathetic nerves for high blood pressure in cases that have a spastic type of hypertension have been successfully performed intrathoracically. The removal of the thymus gland, when it is involved in a tumor or a cyst, is sometimes indicated, and this operation will also lessen the severity of myesthenia gravis, a disease characterized by severe muscular weakness. Further thoracic operations include the removal of tumors in the mediastinum, such as lipomas, dermoid cysts, bronchial cysts, neurofibromas, pericardial cysts, and a variety of others.

## ABDOMINAL SURGERY

Abdominal surgery is the general term for surgery performed on various abdominal viscera, such as the stomach, the intestines, the liver, the gall bladder, the pancreas, and the spleen.

**Gastrointestinal Surgery.** Gastrointestinal surgery comprises the largest portion of the general surgeon's work. It includes the stomach; the small intestine, comprised of the duodenum, the jejunum, and the ileum; and the colon, comprised of the caecum, the ascending colon, the transverse colon, the descending colon, the sigmoid flexure, and the rectum. The pathology differs in different parts of the intestine, and each organ must therefore be dealt with separately.

*Surgery of the Stomach.* The conditions of the stomach requiring surgery are ulcers, tumors, gunshot wounds, and foreign bodies. Ulcers, which produce defects of the lining of the stomach, may be treated by a diet that will produce decreased acidity in the stomach, but if this treatment proves ineffective surgery is indicated. The operation of choice is a subtotal gastrectomy, removing the lower half or two thirds of the stomach and attaching the open end of the stomach to the side of the small intestine. A more recently developed operation cuts the vagi nerves just as they come through the opening in the diaphragm. Since these nerves regulate the secretion of acid in the stomach, cutting them will allow the ulcer to heal. Sometimes ulcers perforate the stomach wall and admit the acid contents of the stomach into the abdominal cavity. The treatment is an immediate operation to locate and close the perforation.

Other conditions requiring surgery of the stomach are carcinoma of the stomach, which calls for a subtotal gastrectomy to resect the affected areas; the presence of foreign bodies, which may be removed by gastrotomy; gastric hemorrhage, caused by cancer, ulcers, or varicose veins, which may require subtotal gastrectomy; and pyloric stenosis. In pyloric stenosis, a condition found in newborn babies, the sphincter of the stomach at the exit, or pylorus, is greatly thickened and hypertrophied. The abdomen is opened and an incision is made down through the muscle of the sphincter, but not through the mucous membrane. The patients generally recover.

*Duodenal Surgery.* Pathological conditions in the duodenum differ considerably from those in the stomach. Duodenal cancer is extremely rare, but duodenal ulcers are even more frequent than those of the stomach; as in the cases of carcinoma of the stomach and gastric ulcers, the incidence of duodenal ulcers is several times higher in men than in women. If surgical treatment is indicated, a subtotal gastrectomy is performed with the removal of the duodenal ulcer if possible.

*Small Intestine Surgery.* The main indication for surgery of the small intestine is intestinal obstruction. Obstructions may be caused by adhesions, characterized by the formation of bands of connective tissue and generally caused by operations or inflammatory processes; strictures, caused by new growths or inflammation, or present congenitally; hernias, into which a portion of the intestine may work itself and become constricted; volvulus, or the rotation of loops of the intestine upon themselves; intussusception, where the intestine has become telescoped; or paralytic ileus, caused by an overactive sympathetic nervous system which inhibits the peristalsis of the intestine. If the obstruction is complete, an operation should be performed at once and the cause removed. Sometimes Meckel's diverticulum, a congenital pouch on the side of the small intestine, becomes inflamed, producing the same symptoms as appendicitis; it must then be removed and the opening into the intestine closed. Cancer seldom occurs in the small intestine, except at the exit of the pancreatic duct and bile duct.

*Surgery of the Colon.* Conditions of the large intestine requiring surgery are cancer, polyps, intestinal obstructions, and certain forms of colitis. Carcinoma of the colon is common, particularly at the sigmoid flexure; the growth with its glands must be removed and the two ends of the colon anastomosed. If obstruction is present, a colostomy is performed; a loop of colon is brought out on the abdomen, opened, and allowed to drain. The anastomosis is done at a

later date and the colostomy closed. If the rectum is involved, it must be removed entirely and a permanent colostomy performed. The patient's bowels then move on the abdomen. This is cared for and controlled by a special colostomy bag fitted over the opening.

Other conditions calling for surgery of the colon are polyps and ulcerative colitis. Polyps are small masses of tissue covered by mucous membrane and generally attached to the intestinal wall by a narrow pedicle; they should be removed locally, for a high percentage of them become malignant. Ulcerative colitis is caused by an enterococcus or the organisms that cause dysentery; it may also be caused by food allergies. If the symptoms last over three years, an ileostomy should be performed. The distal part of the small intestine is detached from the colon, brought out to the surface of the abdomen, and allowed to empty there. This gives the infection a chance to subside by putting the colon at rest. When the ileum is functioning properly, the entire colon is removed and the patient is fitted with a colostomy bag.

**Surgery of the Liver.** Higher animals cannot survive without the liver. Complete removal of the liver is usually followed by death within two to three days. Surgery of the liver is performed in cases of traumatic injuries, abscesses, cysts, and tumors. Because of its size and consistency, the liver is easily injured. Consequently, liver injuries result in a major portion of the operations performed on the organ. These injuries are of two types: those caused by gunshot wounds and stab wounds, and those caused by blows and kicks over the liver by compression or crushing, or resulting from jack-knifing, a sharp bending of the body. This latter occurs sometimes in newborn babies where the so-called jack-knifing is used to start the baby breathing. Cases of spontaneous rupture have also been reported.

Regardless of the cause, the symptoms are the same. The liver has a rich blood supply, and many bile ducts. Consequently, an opening into its substance will allow the escape of these two fluids into the abdomen, causing irritation of the peritoneum; the patient, therefore, complains of severe pain in the abdomen, and the irritation causes the abdominal muscles to become very tense and sensitive to pressure. If the bleeding is severe, the patient will show signs of shock, which is manifested by a rapid pulse and a falling blood pressure.

If the signs of abdominal irritation are present, or if the patient is showing signs of shock, the abdomen should be opened, the blood and bile removed, the wound in the liver sutured, if possible, and, if not possible, packed, and the abdomen drained. Penicillin should be given in gunshot wounds to prevent the formation of an abscess. During World War II, it was observed that many liver injuries would close spontaneously and did not require a laparotomy, or incision of the abdominal wall.

Liver abscesses may be caused by bacteria or by parasites, such as amoebas. The abscesses may be single or multiple, large or small. Treatment involves opening and draining the abscesses without contaminating the abdominal cavity. Abscesses caused by an organism known as the *Endoamoeba hystolytica* are sterile and do not contain organisms that form pus. Therefore, they are aspirated, and the patient is given a drug called emetine.

Development of a larval stage of the tapeworm, *Taenia echinococcus,* causes cysts of the liver. The adult form of this tapeworm is found in dogs and other canines. The cyst, and also its lining and daughter cells, must be removed intact; otherwise it will merely re-form in such locations as may become contaminated.

Benign or nonmalignant tumors are found in the liver, but are rather uncommon. Malignant ones are found much more frequently. They usually start in other parts of the body and spread to the liver, although occasionally they may originate in the liver. Since 1940, attempts have been made to remove the part involved, but the results are questionable. Treatment is most unsatisfactory.

W. H. B. and W. T. G.

**Gall Bladder and Bile Duct Surgery.** The external secretion of the liver is bile and it empties into the duodenum or first portion of the small intestine via the bile ducts. There are two ducts which emerge from the liver and unite to form one duct. This one is joined by another duct from the gall bladder forming the common duct which empties into the intestines. The gall bladder is a pear-shaped organ situated on the under surface of the liver and contains from 30 to 40 cc. of bile. There are certain pathological conditions of the gall bladder which require treatment by surgery, such as gall stones and inflammatory conditions.

There are many theories as to the cause of gall stones. Infection, metabolic disturbances, and stasis of the bile are the three most probable causes. Gall stones may be 2 to 3 in. in diameter or as small as fine gravel. They may be single or number as many as 4 to 500. Most inflammations of the gall bladder are associated with the presence of stones. Sometimes one of these smaller stones works its way down into the ducts, causing excruciating pain, with nausea and vomiting. If the stone becomes lodged in the common duct, no bile can get into the intestine. The back pressure is so great that the bile gets into the blood system and all the tissues become yellow or jaundiced. The stone may become lodged at the exit of the gall bladder. Frequently either the gall bladder or bile ducts will become infected following the lodging of such a stone. If the patient is a good surgical risk, the treatment of choice is the removal of the gall bladder and cystic duct. Most stones, sooner or later, cause trouble and the only way to avoid this is to remove the organ. This procedure is called a cholecystectomy. If the stones are removed and the gall bladder allowed to remain, stones are apt to reform. When they become lodged in the common duct and the patient becomes jaundiced, surgical intervention is necessary. Occasionally these stones will pass, but if the jaundice increases or remains constant after a period of four to seven days an operation is justified. This operation, which consists of opening the common bile duct, removing the stone and inserting a tube, is called a choledochostomy.

Inflammation or cholecystitis may occur in a gall bladder without stones, but more frequently with stones. The infecting organisms are often those of the intestine, such as the colon bacillus group. In some cases of typhoid carriers, or people who have had typhoid, the typhoid germs may be found in the gall bladder for many years after the original infection.

Sometimes the gall bladder may rupture and cause either a localized abscess or a peritonitis. There are two distinct schools of thought on the treatment. One is to operate as soon as the diagnosis is established and the other is to wait operation until the infection has entirely subsided. In either case the gall bladder should be removed.

**Pancreatic Surgery.** Acute pancreatitis, chronic pancreatitis, pancreatic calculi, pancreatic cysts, and cancer of the pancreas all require surgical intervention. Wounds of the pancreas are classified under two types, gunshot or stab wounds. The treatment is to open the upper abdomen and either suture with silk or pack with gauze. Silk should be

used instead of catgut because the latter is destroyed by the pancreatic enzymes. A drain should always be placed down to the wound in the organ.

There are two schools of thought on the treatment of acute pancreatitis. One is to operate—the other is to treat the patient supportatively by administering saline and glucose intravenously, and by chemotherapy. In the treatment of chronic pancreatitis surgery is undertaken to remove the cause, such as an infected gall bladder or obstruction to the ducts.

Pancreatic stones caused by stasis in the flow of the secretion plus infection should be removed, if possible, but sometimes the calculi are so extensive that the gland itself has to be removed. Cysts of the pancreas are rather rare. Retention and hemorrhagic cysts are more common than hydatid cysts, which are caused by the dog tapeworm. The cyst should be completely removed. Sometimes this is impossible and the cyst wall must be sutured to an opening in the abdominal wall and allowed to drain. This is known as marsupialization. The lining of the sac can then be cauterized at a later date.

Nothing is known of the cause of pancreatic cancer. The tumor is nearly always found in the head which is the part of the gland closely attached to the intestine. The only way the diagnosis can be established is by biopsy. The treatment is one of the most difficult of all surgical procedures. The head of the gland is removed with the portion of the adjoining small intestine. The bile duct is reattached to the intestine and the intestine to the stomach. Sometimes the entire gland is removed. Prognosis of this condition is generally poor.

**Spleen Surgery.** The function of the spleen is to form certain types of white blood cells and blood platelets, to destroy red blood cells, and to store blood. In spite of all these functions, the spleen can be removed with no ill effects to the patient. The following conditions are benefited by surgery: (1) rupture of the spleen; (2) torsion; (3) hemolytic jaundice; (4) thrombocytopenic purpura; (5) Banti's syndrome; and (6) enlarged spleens which cause mechanical distress in which splenectomy (removal of the spleen) is not contraindicated. Gaucher's disease and sickle cell anemia have been treated surgically with questionable benefit.

The spleen is a fairly delicate organ, and in spite of the protection given it by the lower ribs it is sometimes ruptured in accidents. The bleeding may occur at once, or may be delayed for many months. Spontaneous ruptures also occur. The patient should be transfused, and the spleen removed as soon as the diagnosis is established.

Hemolytic jaundice, the result of an inherited defect of the red blood cells, calls for removal of the spleen, as does thrombocytopenic purpura. If Banti's syndrome is diagnosed early, removal of the spleen gives good results; otherwise, surgery is of no value. The spleen is removed through a muscle-cutting incision along the left costal margin.

Gaucher's disease is an inherited disease which disturbs the fat metabolism and is associated with increased size of the spleen. The spleen may be removed surgically, but the results are not entirely satisfactory. Sickle cell anemia is found generally in Negroes, and is characterized by both anemia and splenic enlargement. The value of splenectomy in sickle cell anemia is open to question. W. H. B.

## NEUROLOGICAL SURGERY

Neurological surgery is concerned with the diagnosis and treatment of diseases of the brain, spinal cord, peripheral nerves, and sympathetic nervous system. The neurological surgeon must be neurologist as well as surgeon. The brain and spinal cord are delicate structures which suffer great penalties if they are not carefully treated. Generally, it has been found impracticable to explore the cranium surgically, as, for example, the abdomen is explored, and practice requires exact information concerning the location, extent, and nature of a disease before neurosurgical treatment is undertaken. Technical developments, including anesthesia and asepsis, are also important factors in surgical treatment of the nervous system. The successful penetration of the brain barrier requires such exacting and laborious effort that the mere safe exposure of the brain may occupy more time than that required for complete major operations in more accessible parts of the body.

**Diagnostic Development.** Modern neurological surgery began in the latter half of the nineteenth century, when great strides were made in the collection of data concerning the anatomy, physiology, and pathology of the nervous system. Pioneers in the field used this information to interpret the complaints and abnormalities of their patients and to identify and localize the diseases producing these complaints. However, the body, even the brain, often responds in a similar manner to many afflictions and may endure extensive lesions with little obvious change. For a precise diagnosis, more information was needed than could be obtained by the clinical approach, and this, in turn, required refinements of the methods of acquiring information.

Pneumography, introduced in 1918 by Dr. Walter Dandy at Johns Hopkins University, was among the first of these developments. In pneumography, the cerebrospinal fluid is replaced by some gas, such as air or oxygen, following which X-ray films of the head are taken to show the location and conformation of the gas within the cranium. If the pressure is normal, the exchange may be carried out through needles inserted into the spaces of the lumbar spine (encephalography). If the intracranial pressure is elevated, the exchange is made directly by introducing needles into the cavities within the brain (ventricles) through small openings made in the skull (ventriculography). This single procedure has contributed greatly toward the localization of a disease and in a lesser degree, toward its identification.

Another refinement was the visualization of the intracranial arteries and veins of the brain, again through the medium of the X-ray film. This procedure, known as angiography, was introduced in 1927 by Egaz Moniz, of Lisbon, Portugal. A substance which blocks the passage of X rays (radiopaque substance) is injected into one of the arteries leading to the brain; X-ray films are then made in rapid succession, recording its passage through the arteries (arteriogram) and veins (venogram). Abnormalities of the blood vessels or distortion of their course or distribution can be shown by this means.

Electroencephalography, a study of the electrical activity of the brain by an electronic device, has shown promise since its introduction in 1929.

In the spine, plain X-ray films are valuable in the recognition of skeletal alterations. The localization of tumors and other distortive processes in the spine has been facilitated since 1922, when Sicard and Forrestier, of Paris, showed that certain oily substances containing radiopaque elements could be introduced safely into the spinal canal. After injection, the material can be moved up and down the canal by tilting the patient, and its position can be recorded by means of the X ray (myelography).

**Tumor Surgery.** Tumors or new growths affecting the brain were among the first brain diseases to be treated by

surgery. These tumors may destroy the brain by invading it, paralyze some function of it through focal compression, or irritate it and cause convulsions. Mentality is seldom seriously impaired by brain tumors.

Of all the cranial nerves, the auditory is most commonly affected by tumors. Because of its location, it is extremely difficult to remove all the tumor from its attachment to the highly vulnerable brain stem. The nerve of motion of the face usually lies within the capsule of this tumor and facial paralysis is a complication frequently associated with successful radical removal.

Tumors in the cerebrum are usually reached by reflecting a "flap" of the scalp and by elevating an area of the skull suitable in size and location (osteoplastic craniotomy). The dura mater is then cut, and the brain, covered only by the arachnoid, is exposed. At the end of the operation, the dura mater is closed and the block of skull and the scalp are replaced. The bone beneath the temporal muscle may be removed safely and not replaced, giving some added volume to the cranial cavity. This procedure is called "decompression." When a tumor, such as a meningioma, has invaded the skull, it is sometimes wise not to replace the affected bone, but, instead to cover the exposed area with an inert metal or plastic plate shaped to fit. Similar repair of defects in the skull may be necessary after extensive head injuries.

The cerebellum is usually approached by reflecting the heavy muscles at the back of the neck and by removing sufficient bone to expose the region desired. This bone is not replaced as a rule, the muscles affording sufficient protection to the underlying structures (myoplastic craniectomy).

The spinal cord and its coverings come from the same embryonic source as the brain. Gliomas invade it and usually are not removable. However, the encapsulated tumors of its meninges and nerves which may compress it can be completely removed, and, when found early, have a good prognosis.

A lesion which acts as a tumor of the spinal canal but which is not a new growth is the protrusion into the canal of material from the intervertebral discs, a plate of cartilage and fibrous tissue lying between successive vertebrae. It degenerates with age and may be partly extruded into the spinal canal in such a way that the spinal roots are irritated and produce pain. The low lumbar region is most commonly affected and involvement of the lower cervical region is next in frequency of occurrence. The pain resulting from this irritation is generally relieved by removal of the offending tissue.

**Surgical Treatment of Injuries.** Injury of the nervous system has increased in frequency and severity with the development of mechanical aids to man's movements and productivity.

*Brain Injuries.* The brain may be damaged when the skull is penetrated by a missile, as in a bullet wound, or when the body is thrown against relatively resistant objects, as in a fall or an automobile accident. A penetrating missile causes laceration of the brain, with the resultant hemorrhage producing secondary damage. Bullets are usually sterile, but other penetrating bodies may carry infection themselves. If the head has been thrown against a resistant object, there may be concussion, a state in which there is transitory paralysis of function but no demonstrable permanent change in the brain. The brain may be contused or bruised, which will leave some scar tissue. If the skull is fractured and the overlying scalp lacerated, the wound is said to be compounded and is open to possible infection.

*Subdural Hematoma.* Injury to the head, even of slight degree, may rupture blood vessels, producing damage to the brain by the pressure and destructive effect of accumulated blood between the dura mater and the arachnoid. In this case, as it disintegrates it attracts fluid by osmosis, and the resulting subdural hematoma will produce symptoms as it increases in size. Hematomas within the brain are less common. Most intracranial hematomas can be drained satisfactorily through small openings, although occasionally a large exposure is necessary.

*Spinal Cord Injuries.* The spinal cord also is subject to concussion, contusion, compression, or laceration. Here, too, injury may be complicated by hemorrhage or infection. Compression, as by a blod clot or by bone, may be relieved by laminectomy, but laceration and contusion usually are not benefited by surgical methods.

*Injuries to Peripheral Nerves.* The peripheral nerves also may be lacerated, as by glass, knife or missile, or by the sharp edges of adjacent broken bones. The nerves outside of the cranium and spinal canal will regenerate with varying degrees of return of function if the ends of the nerve can be brought together. Bruised nerves or those compressed, as by scar tissue, may have their function impaired or may become extremely sensitive. The interruption of this binding scar tissue (neurolysis) often may be of benefit.

Sometimes nerves lie where they receive slight but repeated injuries. In such cases, in addition to neurolysis, it may be necessary to shift the nerve to a less vulnerable part of the extremity.

**Brain Abscesses.** Brain abscesses are treated by draining the pus and preventing its reaccumulation, and by keeping the intracranial pressure as nearly as possible within normal limits. An abscess which has formed a capsule may occasionally be completely removed in the same manner as a tumor.

The tissues about the spinal cord are particularly susceptible to infection from the skin and the lungs. Abscess here can be drained by laminectomy, relieving the pressure upon the cord. Abscess within the cord can be drained, but significant improvement is rare.

**Brain Hemorrhage.** Many instances of spontaneous brain hemorrhage are found to result from congenital weakness in the walls of blood vessels of the brain. These weak spots allow a thin sac to protrude from the blood vessel wall. The sac is called an aneurysm. This may rupture with symptoms varying from slight headache to death. It is possible sometimes to ligate the blood vessel, thus removing the danger of rupture.

**Psycho-Surgery.** Certain of the insanities appear to be favorably affected by the operation of frontal lobotomy or leukotomy, in which the fiber pathways connecting the frontal lobe of the brain with the remainder are severed. This operation, first described in 1935 by Egaz Moniz, has been used in selected cases with promising results.

**Surgery of Epilepsy.** Certain types of convulsive seizures are the result of irritation from the scars of the brain caused by injuries. Removal of such a scar may result in reduction or elimination of the seizures. The results in carefully selected cases have been promising. Most convulsive states are not due to conditions amenable to surgery.

**Relief of Pain.** Man is afflicted by many diseases which continue to defy the physician's efforts at treatment. Pain is a major manifestation of some of these—so much so that, from the point of view of the sufferer, anything, even numbness, is desirable by comparison. The nerve supplying sensation to the face is subject to a painful condition of uncertain

origin known as trigeminal neuralgia or *tic douloureux*. The pain can be relieved temporarily by injecting the nerve with alcohol, or permanently by cutting the nerve near the brain stem. Similar pain in the throat (glossopharyngeal neuralgia) can be helped by spraying with a local anesthetic or by cutting the nerve, again near the brain stem.

Pain elsewhere, resulting from incurable diseases, may be helped by deliberately cutting the pathway for pain in the spinal cord. This operation, cordotomy, preserves all sensations but pain and temperature appreciation and is particularly adapted to relief of pain in the lower part of the body. When cordotomy is not suitable, it may be necessary to cut the sensory nerves to an area and produce complete numbness. Sometimes any surgery is unwise and alcohol can be injected into the spine, giving some transitory relief, although often with undesirable side effects.

**Sympathetic Neurological Surgery.** The sympathetic nervous system may carry impulses related to pain, especially that associated with injury to peripheral nerves and to blood vessels. Injection of local anesthetic into the vicinity of the related sympathetic chain of ganglia, or their surgical removal (sympathectomy), may be required to obtain suitable relief. Only a few diseases can be treated successfully by this method. Among those giving some promise of being aided is arterial hypertension, or high blood pressure. Sympathectomy is often an effective way of dealing with this disease when irreversible changes in the essential organs such as the kidneys and heart have not as yet been produced. Sympathectomy at appropriate levels is also utilized in the treatment of certain vascular diseases of the extremities, particularly the vascular spasm of Raynaud's disease and Berger's disease.

**Congenital Anomalies.** The maldevelopment of the body, especially as it concerns the nervous system, may cause physical handicaps without impairment of mental faculties.

*Meningocele.* The commonest handicap is a meningocele. This is a development defect in the skull or vertebrae which may allow protrusion of the meninges. Surgical repair of this sac may be necessary to prevent rupture, meningitis, or progressive related change in the nervous system.

*Hydrocephalus.* Hydrocephalus, or water-on-brain, is an excess cerebrospinal fluid which may result from overproduction of fluid or interference with its absorption (communicating hydrocephalus), or from blockage of the fluid pathways within the brain (noncommunicating hydrocephalus). The latter can sometimes be helped by connecting the ventricle of the brain with the subarachnoid space by means of a tube. Unfortunately, the more common communicating hydrocephalus is rarely successfully treated.

*Vertebral Anomalies.* Congenital anomalies of the vertebral bones may exert pressure on the spinal cord. Laminectomy is necessary to decompress the constricted structures.

*Congenital Cysts.* Congenital cysts occur in the brain and spinal canal. They cause the same symptoms as tumors in the same location and are treated in the same way.

E. B. B.

## ORTHOPEDIC SURGERY

In its present broad concept, orthopedic surgery is that specialty in surgery which treats fractures, injuries, and diseases of the spine, bones, muscles, tendons, and joints.

### SKELETAL DEFORMITIES

**Club Feet.** The Greeks treated club feet by stretching and wrapping the foot firmly with bandages impregnated with some white of egg solution in glycerine, which, when hardened, tended to serve the same purpose as the modern plaster of Paris cast. By this means, the foot was slowly stretched to a straight position and held there. Although the method was primitive, its basic principles are still used. In the eighteenth century, the marked deformed club foot, which had not been treated by these methods, was helped by the new development of lengthening the Achilles tendon, as originated by Lorenz in 1782. The modern method of correcting club feet is essentially that of the ancient Greeks, with the added advantage of using plaster of Paris as an adequate support. A club foot, noticed at birth, may have a plaster of Paris boot applied after stretching the foot to the corrected position. If the boot is reapplied at weekly intervals for a three-month period, until the child's foot grows into this overcorrected position, the club foot can be effectively corrected in most cases. There are always some few children who require subsequent lengthening of the Achilles tendon. These operations become less frequent the earlier the child is treated. When the modern orthopedic surgeon examines the untreated club foot of an adolescent child, he may find it necessary to perform a bony fusion operation, in addition to using the original plaster stretching and wedging that is a standard form of preliminary treatment. Children whose feet have been thus corrected grow up to have excellent use of their feet, and may indulge in sports and other normal activities. Usually, such children have some slight difference in the circumference of the calf muscles and in the length of the feet, the affected foot being slightly smaller in shoe size. The length of the affected leg, however, is normal.

**Metatarsus Varus.** The deformity of metatarsus varus is essentially a mild degree of contracture of a club foot, and is easily corrected by the application of a plaster boot alone. This deformity, too, is best handled during the first days of the infant's life. A foot of normal appearance should always result from treatment, since this common deformity lends itself easily to correction.

**Scoliosis.** Curvature of the spine is usually noticed in the growing child near the age of twelve. It is ten times more frequent in girls than in boys. Although many conditions may cause this type of deformity, such as an aftermath of infantile paralysis or Von Recklinghausen's disease, the major cause for this condition is unknown. As a general rule, the curve increases as the child grows, and stops when growth has been completed about the fifteenth year of life in the female. From that time onward, very little increase in the curve occurs, except for the normal amount of sagging that would take place with advancing age or with arthritis of the spine. The curve is usually not painful, and is not noticed until a considerable amount of curvature can be demonstrated by X ray. If it appears early in adolescence, the curve will increase markedly by the time the individual is fully grown. In the past, curvature of the spine was treated with braces, which attempted to push the spine into a more upright position and hold it there. This treatment failed to remove the underlying cause of the curve, and when the brace was removed, the curve sank back to its original position. The employment of special exercises, which stretch the contracted ligaments and muscles on the concave side of the curve, has been of benefit, but is rarely successful in making a completely straight normal spine. The modern treatment is to bend the spine into a corrected position by the use of a plaster body jacket, and then fuse the spine, after the technique of Russell Hibbs, so that the affected area of the spine will be welded or fused together into a compact mass and will not bend any more through that area. Although this operative method does not hit at the fundamental cause which produces the curve, it mechanically

holds the spine straight in spite of the forces which tend to produce the scoliosis. The usual technique is to apply a plaster body jacket, with the child bent over in the direction opposite to the curve in the spine. Either new plaster jackets are applied at weekly intervals to increase this bend to straighten the curve, or the plaster is cut in the middle and wedged firmly in the proper direction. When the curve has been straightened as far as possible, the back portion of the plaster jacket is cut out, and the operation is performed through the hole in this plaster. Following the operation, the child remains in bed in the original jacket, or in one similarly bent, for six months, when the spine fusion is perfectly solid. Then the child is allowed to walk without support, and the curve will not recur unless there is a failure of fusion of the operative bony mass. Although the spine thus fused is stiff and rigid in the area of the fusion, there is enough motion of the joints above and below the area of fusion to allow these children to appear perfectly normal. They may bend over and touch the floor, and may indulge in sports with freedom.

**Torticollis.** Torticollis, or wryneck, is a contracture of the sternomastoid muscle in the neck of the newborn infant which holds the head bent to one side, with the face turned toward the opposite shoulder. It is thought to be the result of an injury to the muscle at birth. It is corrected by dividing the muscle in the neck, usually just above the collar bone, making sure to divide the two strands of insertion of the muscle at that point. A plaster body jacket with a headpiece is then applied, holding the head tilted to the opposite side from the contracture and the face turned to the affected side, looking slightly upward toward the ceiling. The child remains in this plaster jacket until the divided muscle has healed in a lengthened position. Then the neck is massaged and stretched twice daily to maintain the full degree of correction. Babies affected with torticollis may be operated on as soon as their feeding has been well established. It is better to operate early than to wait until after the first year of life. If the contracture is not operated upon, the affected side of the face remains underdeveloped as compared to the normal side, so that the affected side of the face looks flatter, with the cheekbones sunk inward. The eye on this side of the face will be smaller and at a lower level than the normal one.

**Birth Palsies of the Shoulder.** Sometimes a baby, during birth, incurs such severe damage to the ligaments and nerves of the shoulder and neck that contractures develop in the shoulder, causing birth palsies. Such a deformity leaves the child with the arm held closely against the side in a contracted position, with the arm internally rotated, so that he is unable to move the hand far away from the abdomen, or stretch the arm overhead. If the nerve in the neck has not been completely torn, the use of massage with special exercise and the employment of a brace holding the arm in a corrected position may allow the damaged tissues to heal satisfactorily. Sometimes, however, the tearing of the nerve is so severe that it leaves the forearm and hand withered and useless. William II, emperor of Germany, had such an arm. The vast majority of birth palsies, however, are of mild degree, and improve with conservative treatment. Some patients develop contractures of the muscles in the shoulder joint, and consequently hold the arm against the side. Such cases can be relieved by an operation developed by James Warren Sever of Boston. The subscapularis muscle is divided at the shoulder joint, and the arm is then held by a brace in the position of "hands up" until the muscle has healed in its lengthened position.

**Congenital Dislocation of the Hip.** Congenital dislocation of the hip was recognized by the Greeks, and attempts to reduce such dislocations were made by successive generations of practitioners who resorted to direct longitudinal traction or pull. Congenital dislocation of the hip was generally considered to be incurable until 1888, when Agostino Paci described his method of reducing congenital dislocations by five complicated and precise movements. Eight years later, Adolph Lorenz, of Vienna, described another method of correction, which was essentially the same as that of Paci.

This method of "bloodless surgery" later gained widespread renown. The apparent success of Lorenz may have been due to the fact that he kept his patients longer in plaster than did Paci. This long immobilization in plaster allowed the socket of the hip to develop a greater depth, so that the hip would not later dislocate.

The modern concept of the treatment of this condition, however, is that only a small per cent can be successfully treated by manipulation alone. The modern trend is definitely toward adequate early surgery, involving complete socketing of the head within the hip joint, and removing the excess tissue present there that allows the head to slip out of place again. Some of these hip sockets, even then, remain shallow, and later may require a bone-graft operation to make an overhanging roof or shelf to stabilize the head in place. All of them require a second operation on the femur, or thighbone, to correct a torsion that tends to dislocate the head from the socket. In dislocated hips, as in other congenital deformities, the earlier the child is treated adequately, the better is the end result.

### DISEASES

**Tuberculosis.** Prior to the discovery of Russell Hibbs, in 1910, that fusion of a joint could successfully arrest tuberculosis, the treatment of bone tuberculosis had largely been confined to long periods of bed rest, and to excision of the diseased joint where possible. In the lower extremity this operation was not successful. The modern viewpoint is that the joint should be operated upon as soon as possible, and a fusion effected. In an upper extremity such as the elbow or the finger joint, excision is still successfully employed. In the case of the shoulder, spine, and hip joint, however, fusion is the operation preferred. Combined with this surgery, rest for a long period of time is still essential, but the disease can now be successfully arrested without fear that it will recur at some future date at that particular location.

**Infantile Paralysis.** Orthopedic measures in poliomyelitis were formerly directed toward stabilizing the paralyzed limbs by the use of braces. To this treatment has been added the stabilizing operation first discovered by Edward Albert in 1878. By fusion operation, the deformed joints can be straightened as well as stabilized, so that braces may be dispensed with in many cases. This type of treatment has widespread use, particularly in cases affecting the foot, where a subtalar fusion may give a firm platform on which to bear weight. Ankle fusions also have been eminently successful. A knee fusion gives a noticeable stiff-leg gait. A hip fusion gives an excellent gait, so that the patient may walk for miles without pain, frequently without any discernible limp. Curves in the spine following poliomyelitis, a frequent cause of scoliosis, may be straightened and fused. The transplantation of a tendon, to supply a strong tendon in place of a paralyzed one, is more successful in the upper extremity than in the weight-bearing lower extremity. This operation has, however, some value when it involves the knee joint or the foot.

### AMPUTATIONS

Amputation of legs and arms has been performed since prehistoric times. The necessary brutality of the guillotine type of amputation, with boiling oil cauterization, was not improved upon until Ambroise Paré (1510-1590) used a tourniquet to numb the limb, control hemorrhage, and pull back the muscles so that they later would fall over the bone and leave sufficient covering, or padding, for the stump of the bone. Paré actually ligated the bleeding vessels so that the amputation stump did not have to be dipped in boiling oil.

Later, more complicated types of amputation, with refinement in technique, were attempted. Napoleon's surgeon Dominique-Jean Larrey, in 1803, performed many amputations of the shoulder and hip joint, in addition to amputations of the more common type. Jacques Lisfranc, in 1815, described a method of amputation of a part of the foot. Nicholas Ivanovitch Pirogoff of St. Petersburg devised another type of amputation of the foot. James Symes devised an amputation at the level of the ankle joint. It remained for Robert Liston, an Englishman, to introduce, in 1890, the skin-flap amputation, which covered the raw end of the bone and muscle. This type of operation took longer to perform, but healed more quickly and gave an infinitely better result. In 1857, Rocco Gritti amputated at the knee joint and used the patella, or knee cap, turned under the end of a thighbone, or femur, and covered with a skin-flap to serve as the weight-bearing surface.

Originally, surgeons amputated as close to the mangled portion of the limb as was consistent with good healing and good blood supply to the skin edges. A site thus selected, however, did not always prove to be the optimum site of amputation from the standpoint of a limb-maker who had to make the artificial prosthesis. In the beginning of the twentieth century a convention in London, attended by both surgeons and limb-makers, resulted in the selection of optimal sites for amputation by mutual agreement between the two groups.

A remarkable advance was contributed by an Italian physician, Giuliano Vanghetti, who conceived the idea of utilizing the small contraction of the remaining muscles in the amputation stump, so that by means of a mechanism in the artificial limb these movements could be magnified and made to open and close artificial fingers with some degree of skill. This prosthesis is applicable only to the upper extremity. Better results are obtained if specialized training is given to the muscles before operation. This technique of amputation and appliance has a precision of control, and a directness of control, that is better than an artificial limb activated by shoulder-shrugs. The patient even learns a sense of feeling, size, and density. The disadvantages of the technique are a lack of power for the heavy work done by a hook on the end of the appliance. The apparatus is still crude, and parts break easily. The surgery for fine muscle control is still far ahead of modern engineering principles of limb-making. Most soldiers prefer the sturdier, simpler artificial hand that has a hook for heavy work and a simple pinching mechanism for grasping objects.

In modern wars, under anesthesia of course, the guillotine type of operation, together with the tourniquet and vessel ligation employed by Paré three hundred years ago, is still used. It is the safest means of amputation in busy evacuation hospitals where immediate surgery must be performed. As healing takes place, the skin edges are pulled down over the open bone end and held in place by means of adhesive tape traction on the skin, until only a small central scar remains. A plastic skin-flap operation may be performed at a later date at the base hospital if indicated. In civilian life, where speed and haste is not necessary, a skin-flap operation under anesthesia is usually employed. A novel development in amputations has been the freezing of the leg prior to operation. This method is occasionally used on some aged diabetics or other people having diseased blood vessels or infections. Cracked ice is simply packed all about the limb after a tourniquet has been applied high on the thigh. In an hour, anesthesia is complete, and the leg may be amputated without any other type of anesthesia. This type of amputation causes no shock to the patient, and the wound heals satisfactorily.

In choosing the site for amputation, the surgeon is naturally influenced by the findings of the limb-maker, who has learned from experience what sort of stump will fit the most efficient and comfortable artificial leg. In the lower leg, it is generally conceded that the "site of election" is about four to five inches below the knee joint. Many surgeons, however, believe that the Gritti-Stokes amputation through the knee joint gives a more efficient and less troublesome stump. The higher the amputation above the knee, the less efficient is the artificial limb in its function. It is necessary, in the case of these high amputation sites, to employ belt and shoulder straps to hold the artificial leg on the thigh. By means of these straps, however, certain motions of the artificial limb can be produced.

### TRAUMATIC CONDITIONS

Accidents and injuries produce many traumatic orthopedic conditions, such as fractures, or broken bones, and damaged muscles, ligaments, and joints.

**Tendon Surgery.** When muscles, tendons, and nerves have been cut or damaged by trauma, they are operated upon immediately and sewn back together. A severed tendon, when treated early, is usually sutured back to the parent tendon. If not treated until months or years after injury, a tendon graft may prove necessary, or the tendon end may be sewn to a neighboring tendon so as to give it more power. It is possible to transplant an unimportant tendon to fill in a gap left by the injury, especially in the hand. Severed nerves may be sutured together, and the vital portion of the nerve will grow further down the extremity at the rate of about three-quarters of an inch a week. Badly damaged muscles, however, especially if they have been deprived of their blood supply for more than twenty-four hours, never regenerate.

**Torn Knee Cartilages.** The medial meniscus, or cartilage, on the inner aspect of the knee joint is frequently damaged in athletics and in normal civilian life. This may cause the knee joint suddenly to "lock" or get caught in a bent position, so that the individual is unable to straighten his knee. Such an occurrence is usually followed by pain and swelling. When such a knee cartilage is removed, the knee is no longer placed in a plaster cast, but early motion is encouraged as soon as the anesthesia has disappeared. By this method, the patient is usually bearing weight within three weeks of the operation, and the residual function of the knee should be excellent. Many older people develop painful knees as a result of degeneration of this inner knee cartilage. In such cases, pain, if not accompanied by severe arthritis, usually can be relieved by excision of the degenerated cartilage.

**Painful Shoulder.** Trauma or accident may so wrench the shoulder that a portion of its capsule is torn. If this tear is extensive, repair of the torn capsule is necessary to

relieve the patient of pain. Occasionally the capsule undergoes degeneration as the result of frequent minor strains. A small portion will then develop a circular-shaped defect in the capsule where the ligamentous tissue has torn and frayed apart. Such a shoulder is improved markedly by an operation which cuts out the chronically inflamed area and repairs the capsule.

At times, too, the biceps tendon of the upper arm, which runs through the capsule into the joint, will slip out of place at the top margin of the bone. This tendon may have to be firmly anchored into the surrounding structures.

Frequent minor strain on the capsule of the shoulder may result in a deposit of calcium, which forms within the capsule in the process of healing and causes considerable inflammation and irritation, accompanied by severe pain at the point of the shoulder. If the capsule becomes acutely inflamed, it may rupture through into the bursa of the shoulder. Although a few of these calcium deposits can be made to absorb and disappear by conservative measures of massage and deep-heat treatments, many of them require surgical removal.

**Dislocation.** The most common dislocation is that of the shoulder joint. As a rule, the upper arm is dislocated forward and downward, tearing the attachment of the capsule to the socket of the shoulder blade. Such an injury is usually the result of an accident, but some sockets are so shallow, because of improper development, that dislocation may habitually recur. The dislocation is usually easy to reduce if the patient has been anesthetized. Although more difficult, it occasionally may be accomplished without anesthesia.

Habitual dislocation of the shoulder requires surgery. In this operation, the torn capsule and ligaments are reattached, the subscapularis muscle is tightened, and the arm is held bound to the side for six weeks before motion is allowed.

**Low Back Pain and Sciatica.** One of the most common ailments of mankind is a low back pain, called sciatica, in which the pain radiates down the leg. This malady is a frequent result of an injury to the back or of heavy lifting resulting in a tearing of ligaments, so that a portion of the cartilage disk that lies between the vertebrae is protruded backward, and presses on one of the nerves of the spine. The treatment lies usually in the direction of gentle manipulation intended to push the protruded cartilage back into its normal position in the spine. This manipulation, together with some support of the spine in the form of a corset, or brace, plus massage and physiotherapy, enables most people to return to work within a relatively short period of time. If the manipulation is successful, sometimes the sciatica will instantly cease. Special exercises are then used to re-educate the muscles which have been in marked spasm. Recurrences of the protrusion will recur, as a rule, with greater frequency, and they will require less injury to produce them. Surgery may be needed to prevent such recurrences. Patients on whom manipulation is unsuccessful, because too large a piece of material has extruded itself backward and is pressing on the nerve, likewise require surgery.

By surgery, the protruding piece of cartilage can be removed, eliminating its pressure on the nerve. Such excision will relieve the pain and spasm in the back. Additional pieces of cartilage may later be extruded backward through the same area unless the spine is fused by means of a bone operation which prevents motion at that area.

## FRACTURE

Fractures, or broken bones, have been the concern of healers since the dawn of man. Nature has provided a process within our bodies of healing these fractures which is essentially very simple. The blood that flows out around the broken ends clots within a few days and forms a jell which hardens and consolidates throughout the subsequent weeks, and finally turns into bone. This jell, or bony cement, takes many weeks to harden completely into firm bone. It is therefore evident that if the broken bones are held in proper position, this cementing process, when completed, will leave the bone in its proper alignment and shape. If the bones are not held still during the healing stage, angulation, shortening, or deformity may occur. Most fractures occur deep beneath the skin without causing sharp ends of the bone to protrude through the skin. Such fractures are known as "simple" fractures. "Compound fractures" are those which break through the skin, making possible an infection of the blood clot surrounding the bone. If the bone is shattered into many small pieces, the fracture is known as a "comminuted fracture." For thousands of years, the treatment of fractures has been based on the principle of pulling the angulated or overriding fractured bone into position, and holding it there until nature had completed its cementing process. This method of treatment is known as the conservative or nonoperative treatment of fractures.

Bones may also be held in proper alignment by traction during the many weeks during which healing takes place. Traction may be effected by the use of adhesive tape on the skin, or by metal wires pulled through the bone. Constant pull is maintained by the use of weights. This method is highly satisfactory, but requires constant attention and care. It allows a certain degree of motion of the limbs, but has some disadvantage in that it stretches the joints.

Conservative therapy is therefore the treatment of fractures by reduction, followed by either splinting or traction. It is still the treatment of choice for many fractures of the body, especially in children, for many infected or compound fractures, and for most common fractures, such as those of wrist, ankle, collarbone, and shoulder. Healing of the fracture by the bony consolidation of the bone clot occurs at a regular rate throughout the body, but is faster in children than in adults. Certain bones, however, need to be held in alignment by splints or by traction for longer intervals than others.

**Operative Treatment.** Operation on fractures has two main purposes. The first purpose is to reduce and align the fragments into proper position when they cannot be pulled down or manipulated into place by closed reduction. This step may be followed by splinting, or fixation in a plaster cast; the fracture is treated from that point onward very much as in the conservative type of treatment. The second purpose, which has developed since 1905, is not only to reduce and properly align the bone ends, but to hold them firmly in place by means of some metal internal appliance which is firmly screwed or fixed to the bone. When successfully accomplished, this internal fixation of fractures may eliminate the use of external plaster support, and will allow early motion of the joint and freedom of the use of the muscles. There is a danger of infecting the bone in this operative procedure.

The first report of an attempt at internal fixation credits Lapuyade and Sicre in 1775 with using wire to fix the bones in place. They were accused by the French surgeon Icart of causing the death of the patient in two days. In 1827, J. H. Roagers of New York successfully wired an ununited fracture of the humerus, or upper arm. In 1861, E. S. Cooper of San Francisco wired together a fractured patella, or knee cap, which successfully healed without infection. The real

birth of internal fixation of fractures, however, was not to come until 1905, when Sir Arbuthnot Lane of London published his book on the subject. Though various types of metal plates had been used prior to Lane's time, the latter's technique of thoroughly exposing the bone, reducing the fracture, and holding it in place by means of a metal plate screwed firmly to the bone is essentially the technique still employed. Developments since Lane's time have been chiefly minor modifications of his method, following the discovery of metals which are not irritating to tissues, so that the wound does not break down later and cause infection with draining sinuses. With the development of bone-graft surgery, still another method of internal fixation has become available. Inlay and onlay of bone grafts are used not only to stabilize the bone, in the same fashion as were the metal plates, but also to offer additional bone from which more callus and cement can be obtained for added strength.

Though the danger of infection is always real and ever present, the technique of internal fixation has been a great advance in orthopedic surgery. In fractures of the thigh and lower leg, it is possible to maintain full length and obtain union without the use of external support or traction. The patient's expensive stay in a hospital is accordingly reduced to a minimum. The residual function of the neighboring joints is infinitely better. The failure of union and the incidence of deformity are markedly reduced in competent hands and in selected fracture cases. Fractured hips in the aged, considered permanently crippling or terminal accidents in the past, are now treated by means of internal fixation involving the use of a specially shaped nail, with the result that approximately 80 per cent of such patients are able to walk successfully again. The high incidence of nonunion in two areas of the body, namely the lower third of the tibia, about four inches above the ankle, and the middle third of the forearm, has been greatly reduced. In fractures involving the knee joint, the elbow, and the shoulder joint, which formerly left much residual stiffness and loss of function of the joint, the use of open reduction and internal fixation holding the fragments in proper alignment has resulted in much more normal function. F. R. T.

## PLASTIC SURGERY

Plastic surgery deals with the reconstruction of tissue defects and the restoration of body areas that have been lost or deformed through injury, disease, or maldevelopment. It is necessarily associated with all other surgical specialties, but is identified chiefly with the transplantation of skin, bone, and cartilage in the correction of congenital abnormalities and scarred deformities, in cosmetic surgery about the face and breasts, and in the repair of burned surfaces and areas from which cancer has been removed. Its purposes are to establish normal contour and restore function.

**History.** Contrary to most opinion, plastic surgery is not of recent development but dates back to prehistoric times, when primitive man made crude attempts at repairing wounds inflicted by animals and savages. The Egyptians developed reparative surgery into an art and a science, and as early as 3400 B.C., in the First Egyptian Dynasty, healers were performing cosmetic operations on the face, feet, and arms. By 2500 B.C., they were utilizing sutures, adhesive tape, lint dressings, ointments, and antiseptics, and these practices spread throughout Asia Minor and were adopted by the Hebrews, Assyrians, Arabic, and Greek peoples. India, likewise, made early progress, and, by 600 B.C., doctors had employed forehead tissue flaps in the reconstruction of noses, had made free skin grafts from the gluteal region, and had used tissue glue, horsehair stitches, and local anesthetics. In the first century of the Christian Era, Celsus wrote about sliding grafts of tissue and skin; later, Galen described in detail the technique of reconstruction of the nose, ears, and mouth.

After a thousand years of stagnation during the Dark Ages, Gasparo Tagliacozzi in 1597 reviewed the technique of reconstruction of the nose. In the eighteenth century, the ancient Indian forehead flap was introduced into Europe by British surgeons who had seen it performed in India, and in the same century Pierre Desault encouraged the use of the pedunculated tissue flap. Free tissue transplantation, although practiced in ancient times, did not receive clinical application until 1869, when Reverdin proved its great value as a dressing for wounds. Ollier, Wolfe, and Krause furthered the utilization of larger sizes of free grafts, and in 1917 Gillies and Filatov devised the tubed graft.

World War I placed an immediate and vast responsibility upon the limited number of surgeons practicing reconstructive surgery. Unfortunately, progress in plastic surgery has been largely associated with the repair of war injuries and mutilations, and the plastic surgeon has been challenged throughout by the advancement in destructive weapons. Consequently, World War II created an even greater responsibility as new weapons and inflammable agents increased the types and severity of wounds. Thousands of soldiers requiring specialized plastic procedures were treated efficiently in hospitals designated as centers for these cases.

**Recent Developments.** In the past thirty years, covering both war periods, acceptable techniques have been standardized, superior instruments have been developed, and the principle of tissue grafting has been extended to all elements of the body. Actually, however, very little has been added to the theory of plastic surgery in the past 3,000 years. Perhaps the most significant recent advance has been in chemo- and biotherapy (sulpha, penicillin, streptomycin), asepsis and anesthesia. The control of infection has broadened the surgical application of reconstructive procedures and increased the opportunities for success, while new devices in anesthesia have permitted well-controlled surgical functions bringing little discomfort to the patient. Other improvements in surgical technique which were particularly applicable to plastic work were the control of hemorrhage, minimization of trauma to the wound, and the proper use of suturing materials.

**Classification of Grafts.** Tissue transplants may be classified as free grafts and pedicle grafts. The free grafts are severed completely from their original source of nourishment and moved to an independent area from which they will derive their sustenance. Mostly these grafts are composed of skin, but they may include such tissues as bone, cartilage, fat, fascia, muscle, tendon, nerve, gland, cornea, and blood vessels. These transplants are further classified as autogenous grafts, which consist of tissues separated and transplanted within the same individual, and heterogenous grafts, which consist of tissues acquired from another individual or an animal. This latter group comprises the homografts, which are transplanted from a body of the same species, such as man to man or dog to dog, and the zoografts, which are taken from different species, such as dog to man. Homogenous skin transplants are unsuccessful, but may be used as temporary dressing material in very large burned areas. Homogenous cartilage, bone, and corneal grafts are very often successful. Homogenous organ grafts, such as heart, kidneys, and lungs, and zoögenous transplants from animals to man have been unsuccessful.

### SKIN GRAFTS

**Types and Purposes.** The autogenous skin graft is used effectively in the replacement of lost skin in extensive wounds, as a dressing for third degree burns, and as a covering for raw surfaces in injuries and diseases. It promotes rapid, sound healing, reduces convalescence, and mitigates against infection and contraction. In preserving the normal function and shape of a section of the body, the accepted practice is to apply the graft as soon after the injury as practicable. If the wound is clean, this is done immediately.

Free skin grafts are identified as being very thin, or of split thickness, or of full thickness of the skin. They are acquired from a convenient donor site, such as the chest, abdomen, behind the ear, anterior thigh, and lower neck areas, by placing the skin under tension and slicing free the desired thickness with a sharp blade. The Padgett dermatome, introduced in 1938, permitted the operator to cut a graft of calculated thickness, width, and length by glueing the skin of the donor site to a drum, over which slides an adjustable cutting blade.

**Procedure in Grafts.** Practice requires that grafts be moved to the recipient areas without delay. If a short delay is unavoidable, the graft is kept in physiological saline solution or placed back on the donor site; if the delay is long, the graft is refrigerated. During the first forty-eight hours, the transplant receives its nourishment from the plasma in the recipient area. Capillaries gradually grow into the graft, and, by the fifth postoperative day, organic union begins with a layer of fibroblasts (white connective tissue cells) fixing the graft to its bed; then, over a period of weeks and months, nerves, fat, and fibrous tissue grow beneath and into the graft. The thicker grafts have shown less tendency to change color and contract after transplantation. They offer more protection and stability but have a greater incidence of failure to "take" than thinner grafts. Very thin grafts, on the other hand, may become highly pigmented and contract from 30 to 50 per cent of their original size. The split graft of medium thickness, obtained with the dermatome, has been found generally satisfactory.

The recipient area is prepared by washing with soap and water and antiseptics, by removal of excessive tissues which are unhealthy, and by control of bleeding. Recent application of human and bovine coagulants to stop bleeding and developments in chemo- and biotherapy have greatly increased the chances of "take" of the graft. The next step in accepted procedure is to immobilize the graft so that the blood supply may become established, and this is accomplished by sewing the graft into its new bed, and applying pressure dressings. In grafting about the face and in the mouth, it has been found necessary at times to drape the skin over a mold or stent to secure it in its new bed. A recently developed tissue glue, prepared from heparinized plasma, causes the graft to stick to the recipient area and eliminates the need for stitches and pressure dressings. Ordinarily, grafts are not inspected for one or two weeks after the operation.

### PEDICLE GRAFTS

**Types and Procedure.** Many of the plastic procedures on the body require the transplantation of large, thick areas of skin and subcutaneous tissues to add mass and shape and give a healthy, resistant covering to bare bone. This is accomplished by partially raising the desired amount of tissue from the body in such a way that one or both ends are left attached as a source of nourishment. The portion that remains attached to the body is called the pedicle, and it is through this stalk that the blood supply and life of the graft are maintained. The defective area is then brought to the graft, if possible, or the graft is gradually moved to the defective site by means of successive migrations. Grafts are migrated by having them transferred to the arm, and then moving the arm, with the graft growing on it, to the deficient area. These pedicle flaps usually are made in the shape of a tube, and may or may not be lined with skin.

**Various Uses.** These grafts are found to be most useful in orthopedic and facial reconstructive procedures. After transplantation, they maintain their original coloring, which is usually white, and often appear lumpy, but these defects can be overcome later when the grafts are thinned out and color matched to their new area by tattooing.

In the repair of deep scars and wounds of the hand or foot, practice has found it desirable to move the injured member to the donor site when possible. The hand may be placed against the abdominal wall to receive an immediate pedicle or tube flap, or it may be inserted beneath the skin of the abdominal wall and retained there for several weeks, or until the graft has attained a sufficient blood supply to warrant release. The scarred or ulcerated foot may be placed against the opposite calf for direct transfer of a pedicle graft, which is released after several weeks. Immobilization of the affected areas is accomplished with adhesive tape, plaster splints, and metal braces.

These thick pedicled tissue transplants have proved valuable in the repair of great loss of tissue anywhere in the body. Current practice uses other grafts as follows: lined flaps from the forehead (Indian), or arm flaps (Italian), for reconstruction of the nose; thin tubed and pedicle flaps for reconstruction of the orbit and ear; sliding cheek flaps, and lined pedicle grafts from the neck or chest, for building up new lips. The surgery usually is protracted and many operations may be required before the final stage of correction is reached.

### COSMETIC SURGERY

Cosmetic surgery has gained in popularity in the past twenty years. It deals primarily with the removal of scars and blemishes, repair of congenital defects, and improvement in contour. In attaining an inconspicuous scar, procedure requires that the wound edges should be vertical, precise, undermined, and accurately positioned with subcuticular fine silk, horsehair, or wire stitches. Wounds that are created with the intent of removing scars, keloids, tumors, blemishes, tattoos, and wrinkles are adapted to conform with Langer's lines, which are the natural lines of the skin. This minimizes the conspicuousness of the repaired wound.

**Harelip and Congenital Defects.** Congenital abnormalities are varied, multiple, and challenging to the surgeon. They may affect any part of the body, but plastic surgery is primarily concerned with harelips, cleft palates, deformed and webbed fingers and toes, arrested development of the bones of one side of the face, and abnormal ears. Harelips and cleft palates, which not only are disfiguring but interfere with swallowing and speech, are corrected in infancy and childhood usually by two or three operations. Webbed fingers and toes handicap the use of the hands and feet and are a source of embarrassment to young children. A free skin graft is often necessary to correct the web permanently. Surgeons hold that supernumerary fingers and toes should be removed early in life. Maldevelopment of the bones of the face requires a series of operations to arrange properly the distorted areas and build up the deficiencies by adding tissue to the cheek, nose, or jaw. Otoplasty has proved satisfactory for the correction of "lopped" or protruding ears.

**Nose Alterations.** Alteration of the nose involves the re-

moval of cartilage and bone in the large, hump type of deformity, and remodeling of the external shape. Flat or sunken noses are improved by the implantation of a carved piece of bone or cartilage. All incisions are inside the nasal cavity and no visible scars result.

**Face and Neck Lifting.** Face and neck lifting procedures for the purpose of eliminating wrinkles and pouches of baggy tissue have also been effective. Most of the incisions for removal of the tissue are beyond the scalp hair line and the cosmetic result is a firmer covering for the face and a more youthful appearance. The lifting of a paralyzed face with fascial strips taken from the thigh gives an animated expression to what would ordinarily be an expressionless mask. Contours of the face are created by the implantation of bone, cartilage, fascia, or fat. The bone is secured from the hip or shin, cartilage from the rib of the patient or from a cadaver, and fat and fascia from the host.

**Other Operations.** Correction of large and small mouth openings, double or thin lips, burns, scars, and tumors of the lips has resulted in restoration of function and shape. Surgeons sometimes find it necessary to graft skin or mucous membrane into the mouth to make a groove for the proper fitting of a dental plate or to release a scar.

**Psychological Effects.** Surgeons warn that the psychological import of gross deformities in children and adults should be carefully analyzed before any operation is contemplated. These individuals have often been abused and ridiculed about their abnormality and are unusually sensitive. On the other hand, improvement of the general shape and function of a defective organ enhances the patient's opportunities and creates self-confidence. J. J. C.

**SURICATE** [su′rɪket], a South African species, *Suricata tetradactyla,* belonging to the mongoose family, Herpestidae. Known also as the meerkat or slender-tailed meerkat, the suricate is a small animal of slender form, having a tail of about half the body length. The long, soft fur is gray in color and has black, transverse stripes across the hinder part of the back, the head being nearly white and the ears black. The suricate may be readily distinguished by its elongated nose and claws, and by the fact that its ears are differently colored from the rest of the head. The pencilled mongoose, *Cynictis,* is sometimes called the bushy tailed meerkat. G. M. C.

**SURIGAO STRAIT** [su′rigɑ′o], a narrow strait in the Philippine Archipelago separating Mindanao and Dinagat islands on the south and east from Panaon and Leyte islands on the north and west. It connects the Mindanao Sea with Leyte Gulf. From Oct. 22 to 27, 1944, the strait was the scene of a large-scale battle between units of the Japanese and American fleets, in which the Japanese suffered disastrous losses. Their surviving vessels escaped to the west. R. G. B.

**SURINAM** [su′rɪnam], often called Dutch or Netherlands Guiana, an overseas territory of the Netherlands, on the north coast of South America. It is bounded on the north by the Atlantic Ocean, on the east by French Guiana, on the south by Brazil, and on the west by British Guiana (Demerara). It has an area of 55,129 sq. mi. The eastern and western boundaries are formed by the Maroni and Courantyne rivers respectively, and on the south are dense forests, savannas, and the Tumucumaque Mountains, which separate it from Brazil. The Wilhelmina Mountains, 3,000 to 4,000 ft. high, in the interior are the source of a number of rivers, the most important of which are the Suriname, Saramacca, Coppename, and Nickerie, all flowing northward to the Atlantic and forming the principal avenues of transportation. The climate is hot and humid, and there are two wet and two dry seasons. Paramaribo at the mouth of the Suriname is the capital of the colony and the largest city, with a population in 1947 of 75,233. Nieuw Nickerie, with 3,472 inhabitants, is the only other settlement of any importance. The population of Surinam, estimated at 207,684 in 1947, excluding bush Negroes and forest Indians, consists mainly of British East Indians, Javanese, and Negroes working in the mines, towns, and on subsistence farms. Agriculture, timber, and gold and bauxite mining are the major activities, and exports include bauxite, most of which goes to the United States, gold, sugar, rum, coffee, rice, fruits, balata, and timber.

**History and Government.** Surinam was first settled by the English in the early part of the seventeenth century, but in the Anglo-Dutch War of 1665-1667 it was seized by the Dutch, who obtained *de jure* possession of the territory at the Peace of Breda (1667) in exchange for the Dutch colony of New Amsterdam (New York). Surinam was again held by the English from 1799 to 1802 and from 1804 to 1816.

Divided into seven districts, Surinam was administered by a governor and council appointed by the crown until 1950, when it achieved a measure of autonomy through a new constitution and was given control of its domestic affairs. The Netherlands retained control of foreign affairs and defense. *See also* Guianas, The. C. W. D.

**SURINAM CHERRY,** an evergreen shrub or tree, *Eugenia uniflora,* growing as high as 25 ft. It is a member of the myrtle family. The surinam cherry is a native of Brazil, and is hardy in southern Florida and Southern California. The fruit, ½ to 1 in. in diameter, deep crimson when ripe, is 8-ribbed and edible. Preserves are made from it. L. de F.

**SURINAM TOAD,** an aquatic toad, genus *Pipa,* which inhabits the Guianas, Venezuela, and Brazil, and is famous for its peculiar breeding habits. The male directs the protruded oviduct of the female over her back and presses the extruded eggs into her softened skin. The female carries the eggs in these tiny pockets until the young complete metamorphosis. A lid covers each pocket and protects the young until they become tiny toads. The adults have broad flattened heads, huge webbed hind feet, and rather slender front feet which have long fingers ending in star-like tubercles. They grow to a little over 6 in. long. The roughened skins of these toads often harbor poison glands. A. Sv.

**SURNAMES.** *See* Personal Names.

**SURREALISM,** a movement in twentieth-century culture described by André Breton, its founder, as "pure psychic automatism by which it is proposed to express orally, in writing, or by any other means, the real functioning of thought . . . dictation of thought, in the absence of any control exercised by reason, beyond any esthetic or moral preoccupations." It was formally organized in 1924 as a reaction against the sterility of Dada; and it combined Cubism's systematic disintegration of conventional concepts with elements of the new theories of Einstein and Freud. Primarily a metaphysical attitude, it believed in the existence of an ideal higher reality, the *Surréel,* experienced by us only in childhood and dreams, when we knew the true essence and position both of ourselves and of our universe. This state of universal harmony could be regained by breaking the bonds of conventional thought to release the subconscious imagination; then the *Surréel* would be able to de-

velop and, after causing an alteration in the general mode of thought, completely take over man's destiny and transform the unsatisfactory conditions of human existence. However, part of the movement split away in the late 1920's, believing that a more direct revolution would in the wake of social upheaval leave a clean slate on which to work the necessary transformation. Although the movement was mainly literary at its beginning, its painters took the ascendance after 1930, and it was chiefly through them that its ideas and influence spread. Connected with Surrealism at one time or another have been the authors André Breton, Philippe Soupault, Paul Eluard, Louis Aragon, Tristan Tzara, and Robert Delnos, and the painters Francis Picabia, Yves Tanguy, Max Ernst, Salvador Dali, Joan Mirô, and André Masson.

G. R.

**SURREY, EARL OF (HENRY HOWARD)** (c.1517-1547), English poet, son and heir of Thomas, third duke of Norfolk, was born about 1517. As a boy, he made translations from Latin, Italian, and Spanish. Henry VIII chose him as companion for his natural son Henry at Windsor and at the French court, and considered him as a husband for Princess Mary; but Surrey, when fifteen, married Frances de Vere. He served as earl marshal at Anne Boleyn's trial in 1536. Surrey was confined at Windsor in 1537 for striking a courtier and was twice imprisoned—in 1542 for sending a challenge, and in 1543 for shooting stonebows at London citizens and houses. He campaigned in Scotland in 1542 and in France during the next four years. Charles V praised him, and Henry VIII appointed him lieutenant general commanding the English forces. The Earl of Hertford, however, superseded him early in 1546 and in December had him sent to the Tower. Convicted of treason on a trumped-up charge of assuming royal arms, Surrey was beheaded on Jan. 19, 1547.

Surrey's first published poem was an epitaph (1542) on Sir Thomas Wyatt. Following Wyatt, Surrey naturalized the sonnet in English, establishing the new English form of three quatrains and a couplet. His sonnets, published in *Tottel's Miscellany* (1557), inspired Sir Philip Sidney and other Elizabethans. Surrey introduced blank verse into English by his translations from Vergil's *Æneid*.

M. E.

**SURREY,** a county in southeastern England, with an area of 722 sq. mi., bounded by the counties of Middlesex and London on the north, Kent on the east, Sussex on the south, and Hampshire and Berkshire on the west. The chalk hills of the North Downs intersect the county in an east-west direction. From them the surface slopes gently to the Thames River on the north and descends to a plain called the Weald in the southern part of the county. Most of Surrey is drained by the Thames and its tributaries, the Wey, the Mole, and the Wandle. Surrey is one of the five Home Counties of Kent, Surrey, Middlesex, Essex, and Hertford, which surround London. The southern part of London and its suburbs are in northern Surrey. Box Hill, 596 ft., and Leith Hill, 965 ft., are the highest points in southern England. Guildford and Kingston are the county towns, with the assizes at Guildford and the county council at Kingston. The records of Guildford go back to King Alfred's time, in the ninth century. Fuller's earth is worked at Nutfield and Reigate. There are manufactures of drugs, tobacco, woolen goods, and calicoes. The ports on the Thames share the trade of the port of London. Dorking, an old market town, has given its name to a breed of fowls. At Mickleham is a church famous for two weddings: Fanny Burney's in 1793, and George Meredith's in 1864. Epsom salts are named for the mineral springs at Epsom, discovered in 1618. The county returns ten members to Parliament. Pop. 1954, 1,616,000.

S. Van V.

**SURTEES, ROBERT** [sɜ′rtiz] (1779-1834), English antiquary and topographical historian, was born at Durham on April 1, 1779. Educated at Christ Church, Oxford, and at the Middle Temple, he early developed an interest in antiquarian research, the fruits of which are to be found in his great work, the *History and Antiquities of the County of Durham* (4 vols., 1816-1840). He also composed local ballads that were frequently mistaken for traditional poetry. Surtees died at Mainsforth on Feb. 11, 1834. In the same year the Surtees Society was founded to publish documents relating to the history and antiquities of northern England.

E. R. A.

**SURTEES, ROBERT SMITH** (1803-1864), English novelist and writer of sporting stories, was born in Durham in 1803. He was educated for the law and turned this to account in some of his writings. In 1832 he became a founder of the *New Sporting Magazine* and was the editor for five years. His contributions to this magazine were later published (1838) as *Jorrock's Jaunts and Jollities,* which is said to have inspired Dickens' *Pickwick Papers.* Other books by Surtees include *Hillingdon Hall* (1845) and *Mr. Facey Romford's Hounds* (1864). He died on Mar. 16, 1864.

E. F. A.

**SURVEYING,** the technique of locating points on or near the earth's surface. When the areas involved are limited in extent, the earth is considered to be a plane and the work is called plane surveying. A geodetic survey covers so large an area that the true shape and size of the earth must be taken into consideration.

The Egyptians are credited with being the first to carry on surveying operations. Annual flooding of farm lands by the Nile and consequent destruction of monuments marking the corners of individual pieces of property necessitated some system for reproducing obliterated lines and corners after the floods. Hence, much of the early mathematics and surveying concerned property boundaries. The first recorded measurements to determine the size of the earth were also made in Egypt, where the Greek geometer and astronomer Eratosthenes measured a meridian arc in 230 B.C.

SURVEYORS' THEODOLITE

COURTESY OF U.S. COAST AND GEODETIC SURVEY

**Work of the Surveyor.** The earliest tasks of modern surveyors also were concerned with the size and shape of parcels of land, to calculate the areas inclosed and to gather sufficient data to prepare descriptions when the lands were

conveyed by deed from one owner to another. As was the case in Egypt, many of these corners often disappeared and the land lines became obliterated. It then became the task of the surveyor to retrace these lines and to replace the corners in their former positions. The magnetic compass, known to the Chinese as early as 2000 B.C., was used to determine directions when much of the public domain in the United States was being surveyed for disposal to the early pioneers. Directions obtained by the magnetic compass may be considerably in error. More exact directions result from observations on the sun, or on a star.

The purpose of many surveys is the preparation of a map showing roads, streams, buildings, and other features in their correct relative positions, both horizontally and vertically. By studying such a map, new highways, railroads, hydroelectric plants, irrigation schemes, and other engineering projects can be planned. After these structures have been designed, the surveyor is called upon to give lines and grades so that they may become realities. The competent surveyor must have a thorough knowledge of mathematics, physics, and astronomy, since many principles of surveying are direct applications of these sciences. If engaged in land surveying, he must be familiar with the legal principles involved. He should be a neat draftsman, capable of turning out a legible map. He must be aware of the sources of error in his field operations, and must know how to detect and eliminate them from his final results.

## SURVEYING INSTRUMENTS

**Tapes.** Steel tapes, varying in length from 3 to 1,000 ft., are used for the direct measurement of horizontal distances. A 100-ft. tape, graduated decimally into feet, tenths of a foot, and hundredths of a foot, is the most convenient for most field operations. In the construction field, where architects' and engineers' plans for a structure are usually dimensioned in feet and inches, a tape similarly graduated is desirable. Tapes used by the United States General Land Office surveyors are multiples of the 66-ft. Gunter's chain. A tape made of a nickel-steel alloy, known as Invar, which has a very low coefficient of expansion, is used for extremely precise work. Invar tapes are frequently 50 meters long, since most geodetic work is based on metric units.

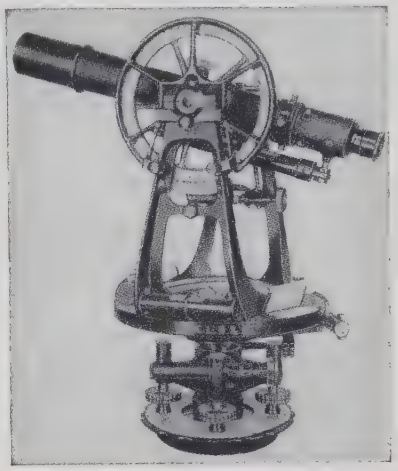
**Transits and Theodolites.** An engineer's transit is indispensable for field operations. It is provided with either an erecting or inverting telescope which can be moved both horizontally and vertically. Graduated horizontal and vertical circles permit the measurement of angles in these planes. European engineers call the transit instruments theodolites. American usage reserves the term theodolite for a more precise instrument.

The directions of the telescope on an ordinary transit can be read by means of attached scales called verniers to 30 seconds (″) or to 1 minute (′) of arc. Some theodolites can be read to 10″; others, equipped with micrometer microscopes or an arrangement of optical prisms, permit readings of tenths of seconds to be made. A bubble tube attached to the telescope enables the instrumentman to bring the telescope to a horizontal position when the transit is being used as a level.

**Engineer's Levels.** The engineer's level differs from a transit in that the telescope can be rotated in only a horizontal plane, and no angles can be measured with it. It has only one bubble tube. The telescope is brought into a horizontal plane by leveling over one pair of leveling screws, then turning it 90° and leveling with the other pair.

There are two common types of levels, the wye and the dumpy. The telescope of the wye level rests in Y-shaped supports and is held in place by hinged clips. These clips can be opened and the telescope turned end for end in the wyes when the adjustment of the instrument is being tested. The telescope of the dumpy level is rigidly attached and cannot be removed from its supports. It has fewer moving parts and requires adjustment less frequently than the wye level.

A level of the dumpy type is used for work of the highest precision. It has three leveling screws instead of the customary four. Approximate leveling is accomplished by observing the position of a small circular spirit level. The final centering of a very sensitive telescope bubble is achieved by turning a tilting screw, located near the eyepiece end of the telescope. A mirror, or an arrangement of optical prisms, enables the levelman to note the position of the bubble at the instant observations are being made. Three horizontal cross hairs permit more exact observations and the determination of approximate horizontal distances. The telescope has a much higher magnifying power than is found on less precise levels.



*SURVEYORS' TRANSIT*

COURTESY OF
C. L. BERGER & SONS

**Plane Table.** The plane-table outfit is used for topographic mapping. It consists of a drawing board supported by a tripod. The board can be leveled and rotated into any desired position without disturbing the tripod legs. Observations are made with the alidade, which consists of a metal ruler or straightedge supporting a telescope.

The telescope moves horizontally as the ruler is turned; it has a vertical movement in a plane that contains the edge of the straightedge or is parallel to this edge. It is equipped with a level tube and has a vertical circle for the measurement of vertical angles. Three horizontal cross hairs, called stadia hairs, allow the topographer to measure horizontal and vertical distances.

**Other Equipment.** In addition to the instruments previously mentioned, certain other small equipment is needed. Plumb bobs and a hand level are required for taping distances over rough ground. A variation of the hand level, the clinometer, is utilized to determine the slope of the ground surface when moderate precision is sufficient. A spring balance is used to maintain a uniform tension. Temporary locations of the tape-ends are marked on the ground by large spikes, or by more elaborate measuring pins made of heavy wire, often painted or enameled. Rods of metal or wood, pointed at one end and painted in distinctive colors, are used for transit work. These rods are called sight rods, line rods, or pickets. The common type of leveling rod is wooden, graduated in hundredths of feet. For stadia work,

longer distances are encountered, and a rod with coarser graduations is necessary.

## LEVELING

If the earth's surface were entirely covered with water and if there were no tides or waves, the resulting surface would be a level one. The elevation of a point is its vertical distance above or below the level surface known as mean sea level, which has been determined by gauge readings extending over many years. Some vertical distances can be measured directly with a tape. Others are determined trigonometrically by measuring a vertical angle, and a horizontal or a slope distance. For approximate values, an aneroid barometer can be used. Results obtained with a level and a rod are the more precise.

Two government agencies, the U.S. Coast and Geodetic Survey and the U.S. Geological Survey, have run many lines of levels over all parts of the United States and have set monuments at frequent intervals. These monuments, called bench marks, consist of bronze disks, usually set in the tops of concrete posts. Their elevations above mean sea level have been very accurately determined, and they serve as starting points for the surveys of local engineers and surveyors.

**Differential Leveling.** When the primary purpose of the leveling is to determine the elevation of a distant bench mark (B.M.), the work is called differential leveling. The procedure is indicated in Fig. 1, where the elevation of B.M. *A* is known and that of B.M. *B* is required. The level is set up where a rod held on B.M. *A* can be viewed through the leveled telescope. This rod reading, $+s$, is the vertical distance from the bench mark to the horizontal plane of the telescope. The elevation of the telescope, called the height of instrument (H.I.) can be obtained by adding the rod reading to the known elevation of the bench mark. The rod is then moved toward the distant bench mark and a rod reading, $-s$, taken on some stable point. The point where the rod is held is called a turning point (T.P.) and permits the levelman to move his instrument from one position to another. If the $-s$ rod reading is subtracted from the H.I., the elevation of the T.P. is obtained.

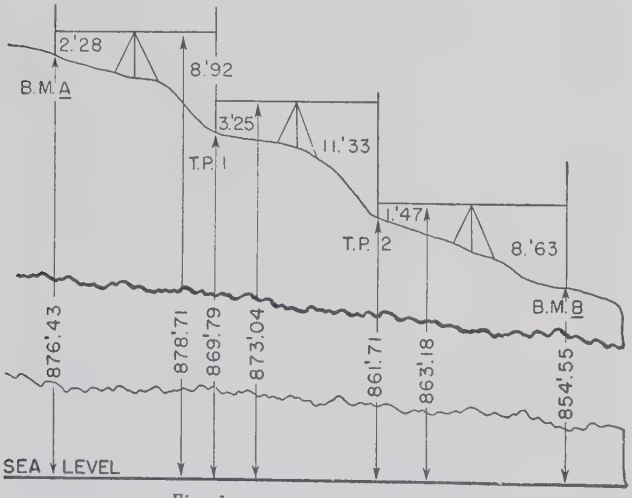
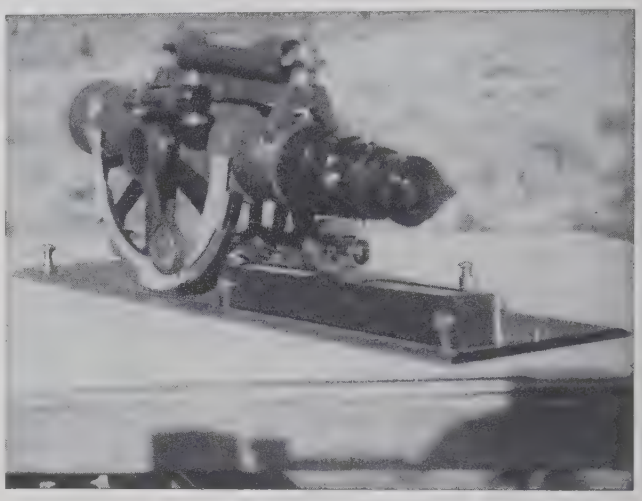



*Fig. 1—DIFFERENTIAL LEVELING*

These two operations, a reading on a point of known elevation and another on a point of unknown elevation, are the fundamental steps in leveling. After the level is moved, a sight is taken on the turning point to the rear and on a new forward one. This process is repeated until a rod reading can be taken on the distant bench mark. Levels should be run over the line in the reverse direction to check the accuracy of the rod readings.

**Profile Levels.** The object of profile leveling is to determine the elevations of the ground surface along some definite line. These elevations are required whenever a railroad, highway, sidewalk, canal, sewer, or transmission line is to be designed. The route followed may be a single straight line, a broken line, or a series of straight lines connected by curves. From elevations determined in the field, a graphical representation of the intersection of a vertical surface with the surface of the earth can be prepared on paper especially ruled for the purpose. A vertical scale much larger than the horizontal one is used to accentuate the differences in elevation.



COURTESY OF STANDARD OIL CO. (N.J.)

*SURVEYORS' ALIDADE AND PLANE TABLE*

The route followed usually is marked on the ground by stakes set at uniform distances apart, say 100, 50, or 25 ft., depending on the regularity of the ground surface and the accuracy required. The beginning point of the survey is designated as Station 0. Points at multiples of 100 ft. from this point are termed full stations. Thus, points at distances of 100, 200, 500, and 1,000 ft. from the starting point are Stations 1, 2, 5, and 10, respectively. Intermediate points are designated as pluses. A point 1,428.75 from the beginning point is Station 14 + 28.75.

The difference in field work between profile and differential leveling is in the number of $-s$, or foresight readings, taken from each setting of the level. In differential leveling, only one such reading is taken. In profile leveling, readings are taken on as many points as are visible from a position of the level, and which are not too far distant from the instrument. The elevations of these points are calculated by subtracting the $-s$ readings from the proper H.I. When no more points along the profile can be seen, a $-s$ reading is taken on a turning point and the level is moved forward along the line. Bench marks are established at frequent intervals, if they have not been set beforehand, and check levels are run between them to detect and eliminate errors.

**Grade Elevations.** A grade line is drawn on the plotted profile to indicate how the original surface shall be altered during the proposed construction. The rise or fall of the grade line, in feet per 100 ft. of horizontal distance, is called the per cent of grade. The selected grade line should have suitable rates of grade and, in the case of a highway or rail-

road, the volumes to be moved should not be prohibitive. The excavated material is used in embankments when the distance to be hauled is not too great.

The edges of deep cuts and fills are found by trial on the ground. When the grading is nearly complete or before forms are set for a concrete pavement, or before the rails and ballast are placed on a railroad grade, stakes are set at the grade elevations. The grade elevation at a survey station is calculated from the grade line. The H.I. of the level is obtained by taking a $+ s$ reading on a bench mark or other point of known elevation, and the stake is driven until the $- s$ reading on it is equal to the difference between the H.I. and the grade elevation. On building-construction projects, required elevations are set in exactly this same manner, that is, by subtracting the required elevation from a known elevation of the level.

## LAND SURVEYING

**Purposes.** The purposes of land surveying are to subdivide large parcels of land into smaller ones, to determine the size and shape of existing parcels so that deed descriptions can be written to permit its legal transfer, and to attempt to relocate the lines of earlier surveys which may have become obliterated.

In the older sections of the United States, the boundaries of many farms are natural ones, such as watercourses, tops of ridges, or bottoms of valleys. The directions of these boundaries were determined with a magnetic compass in the original surveys, and the lengths were measured with a Gunter's 66-ft. chain. The restoration of the original corners is often a difficult assignment, calling for considerable skill and infinite patience in the search for possible remains of the original corners.

**United States Public Land Surveys.** The United States rectangular system of survey of public lands was inaugurated for the disposal of the public domain. It provided for marking the lines on the ground, and furnished a simple method of property description. The original ordinance, passed on May 20, 1785, established townships 6 mi. square, containing 36 sections, 1 mi. square each. It was soon found that the requirement of true north-south and east-west boundary lines was a geographical impossibility. Improvements in surveying methods have resulted in numerous changes in the original survey instructions.

The first step in making the survey was to establish an initial point near the center of the area being subdivided. A principal meridian was then run north and south through the initial point to the boundaries of the tract. Monuments were set at half-mile intervals along this line to mark the quarter-section and section corners. The second line was the base line, which is a parallel of latitude, extending east and west from the initial point to the limits of the survey. It is a small arc which, when marked on the ground, becomes the arc of a circle with chords one-half mile in length. Additional parallels, called standard parallels, were run at multiples of 24 mi. north and south of the base line. The area was divided next into quadrilaterals approximately 24 mi. on a side by running guide meridians at multiples of 24 mi. east and west of the principal meridian. These guide meridians extend 24 mi., or from one parallel to the next, to prevent the effects of the convergence of meridians from becoming excessive. The township boundaries were formed by running meridians north for 6 mi., and then connecting that township corner with the one slightly less than 6 mi. west of it. The discrepancy in distance due to convergence was thrown into the last half mile.

In dividing the township into sections, the north and south lines were run parallel with the east side of the township, rather than as true meridians. All errors in chaining were thrown into the most northerly half miles of the township, and the discrepancies due to convergence were thrown into the most westerly half miles. The full sections should contain 640 acres, whereas any section in the west tier may be expected to contain less than that acreage.

**Legal Descriptions.** One of the aims of the United States system of land subdivision was to provide a simple method of property description. The "N.W. ¼, S.E. ¼, Sec. 22, T. 3 S., R. 7 W., Third Principal Meridian," is an example of such a description. This 40-acre parcel is located in the township which is the third one south of the base line and the seventh west of the principal meridian. Since the sections within a township are always numbered in the same way, the position of the section within the township is definite.

The original survey monuments were set at half-mile intervals along the section lines. The division of section 22 into quarter-quarter sections is the task of the local surveyor. Quarter sections are formed by connecting the quarter-section corners on opposite sides of the section by straight lines. The intersection of these two lines is the legal center of the section. The southeast quarter of this section is divided into quarter-quarters by finding the mid-points of the boundaries of the quarter section and running lines to connect the opposite mid-points. The northwest quarter of this southeast quarter is the piece which has been described. The rules for the subdivision of sections along the north and east sides of the township are somewhat different.

**Metes and Bounds.** Where the rectangular system of subdivision has not been used, parcels of land are described by metes and bounds. In this type of description, the bearing and length of each side are given, together with the starting point and a statement of the objects used as corner monuments. A plat or map, drawn to scale, frequently accompanies the description.

**State Coordinate Systems.** The United States Coast and Geodetic Survey has calculated the plane coordinates, on a state-wide basis, of many monuments set by that organization and by some other survey agencies. These plane coordinates are the distances, in feet, by which the point is north and east of a definite starting point or origin. The length and direction of any line can be computed if the coordinates of the ends of the line are known. If a property survey can be connected to one of these monuments by measuring the angles and lengths of the lines joining the monument with one or more of the property corners, the coordinates of all the corners of the property can then be calculated.

## CALCULATION OF AREAS

**Field Measurements.** The most frequently used method for determining the area of a parcel of land is known as traversing. It consists of measuring the lengths of the sides and either the interior angle at each corner, or the angles which the sides make with a meridian. These latter angles are called azimuths, and are measured clockwise from the meridian. Most surveyors measure them clockwise from the north point; geodesists and astronomers reckon them from the south.

If the survey has been connected with monuments of the U.S. Coast and Geodetic Survey, the azimuth of a starting line can be secured from the information provided by that agency. The transit is manipulated so that the azimuths are obtained directly from the plat readings, or they may be

calculated from the one known azimuth and measured interior angles. When no known azimuth is available, one can be determined astronomically. Where the sole purpose of the survey is to ascertain an area, azimuths can be measured with respect to an assumed meridian.

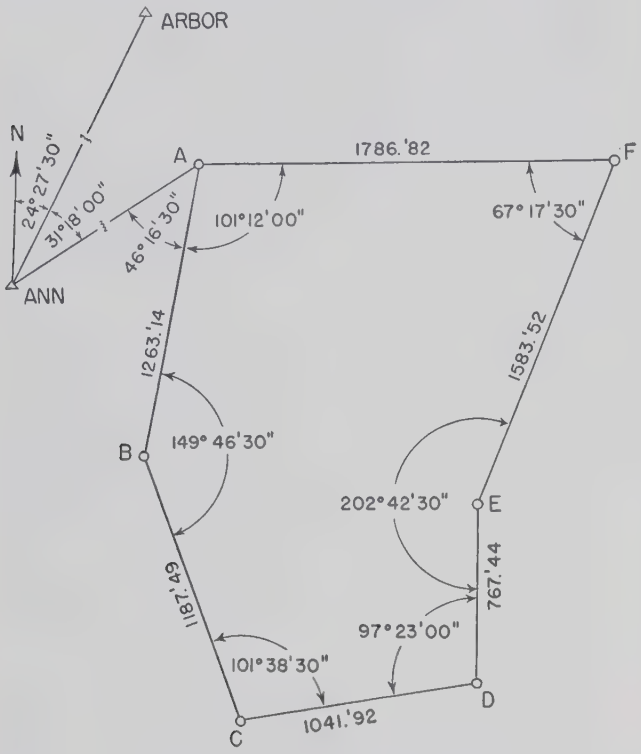



*Fig. 2—CALCULATION OF AREAS BY TRAVERSING*

The accuracy of the azimuths is tested by occupying the first transit point a second time after going entirely around the figure, and comparing the final azimuth of the starting side with its original value. The difference between the two is a measure of uncompensated errors. When interior angles are measured, their sum should total $(N - 2) \times 180°$, where $N$ is the number of angles in the closed figure.

**Office Computations.** The computation of the area of traverse can best be explained by reference to Fig. 2. In this survey one corner, $A$, has been connected with a triangulation system and the interior angles and lengths of the sides have been measured. From these angles the azimuths of the sides have been calculated. If the length of a side is multiplied by the sine of its azimuth, the east and west projection of the side, called the departure, is obtained. Multiplying by the cosine gives the north and south projection, called the latitude of the side.

Since the figure is a closed one, it is obvious that the sum of the east distances should equal the sum of the west ones and the sums of the north and south latitudes should also agree. Although the above sums are not identical, they are well within reasonable limits of error. The errors are distributed in proportion to the lengths of the sides, and the corrected values are used in computing the coordinates. These are the distances by which the corners of the parcel are east or west and north or south of corner $A$. The plus distances are east and north while the negative ones are west and south.

**Area from Coordinates.** The area can be calculated by the coordinate formula, in which the double area is obtained by multiplying each $X$ coordinate by the difference between the $Y$ coordinates of the two adjacent stations, always taken in the same order.

AREAS FROM COORDINATES FOR FIG. 2

| | | | + | − |
|---|---|---|---|---|
| $X_A(Y_B-Y_F)$ | 0.00 | (−1,245.95− 53.62)= | | |
| $X_B(Y_C-Y_A)$− | 208.04 | (−2,356.53− 0.00)= | 490,250 | |
| $X_C(Y_D-Y_B)$+ | 212.60 | (−2,191.79+1,245.95)= | | 201,080 |
| $X_D(Y_E-Y_C)$+1,241.48 | | (−1,424.73+2,356.53)= | 1,156,810 | |
| $X_E(Y_F-Y_D)$+1,218.54 | | ( +53.62+2,191.79)= | 2,736,120 | |
| $X$ $(Y_A-Y_B)$+1,785.91 | | ( 0.00+1,424.73)= | 2,544,440 | |
| | | | 6,927,620 | 201,080 |
| | | | −201,080 | |
| | | 2 | 6,726,540 | |
| | | | 3,363,270 sq. ft. | |
| | | | =77.21 acres | |

**Area by Double Meridian Distances.** The double meridian distance of a side of a traverse is the sum of the two parallel bases of the trapezoid formed by drawing lines from the ends of the line perpendicular to the meridian through the most westerly station. If the double meridian distances are multiplied by the latitudes of the corresponding

COMPUTATIONS FOR FIG. 2

| *Side* | *Azimuth* (° ′ ″) | *Length* (*feet*) | *Departures* (*feet*) | | *Latitudes* (*feet*) | | *Coordinates* | | *Sta.* |
|---|---|---|---|---|---|---|---|---|---|
| | | | *East* | *West* | *North* | *South* | *X* | Y | |
| *A-B* | 189 29 00 | 1,263.14 | ..... | 04<br>208.~~12~~ | ..... | 95<br>1,245.~~88~~ | 0.00 | 0.00 | *A* |
| *B-C* | 159 15 30 | 1,187.49 | 64*<br>420.~~56~~ | ..... | ..... | 58<br>1,110.~~52~~ | − 208.04 | − 1,245.95 | *B* |
| *C-D* | 80 54 00 | 1,041.92 | 88<br>1,028.~~81~~ | ..... | 74<br>164.~~79~~ | ..... | + 212.60 | − 2,356.53 | *C* |
| *D-E* | 358 17 00 | 767.44 | ..... | 94<br>22.~~99~~ | 06<br>767.~~10~~ | ..... | + 1,241.48 | − 2,191.79 | *D* |
| *E-F* | 20 59 30 | 1,583.52 | 37<br>567.~~27~~ | ..... | 35<br>1,478.~~43~~ | ..... | + 1,218.54 | − 1,424.73 | *E* |
| *F-A* | 268 17 00 | 1,786.82 | ..... | 5.91<br>1,786.~~02~~ | ..... | 62<br>53.~~53~~ | + 1,785.91 | + 53.62 | *F* |
| | | 7,630.33 | 89<br>2,016.~~64~~ | 6.89<br>2,01~~7.13~~ | 15<br>2,410.~~32~~ | 10.15<br>2,4~~09.93~~ | 0.00 | 0.00 | *A* |

*Corrected value

sides, the algebraic sum of the areas is the double area of the traverse. Areas formed by north latitudes are considered positive; those formed by south latitudes are negative.

## ROUTE SURVEYS

The center line of a railroad, highway, or canal consists of a series of straight lines connected by curves. The grade line on the profile also is made up of straight lines and curves. The curves used for the horizontal alignment are arcs of circles and spirals; the curve connecting the straight lines on a grade line is a parabolic arc. Horizontal curves on high-speed railroads and highways are made up of three

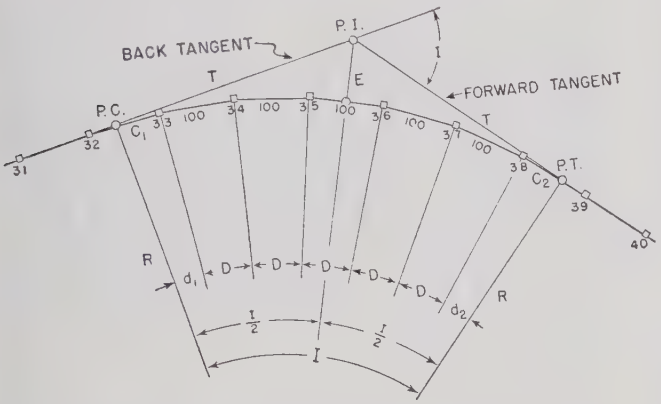



*Fig. 3—SURVEYING A CIRCULAR CURVE*

sections: first, a curve of varying radius; next, the central portion, which is circular; and, finally, a second variable-radius curve connecting the far end of the circle with the new straight line.

The necessity for the spiral or easement curve is to permit a gradual raising of the outer rail with respect to the inner one. For a velocity of $v$ ft. per second, the outer rail, which is $g$ ft. from the inner one, should be elevated $gv^2/32.2R$, where $R$ is the radius of the curve, also in feet.

**Circular Curves.** Although theoretically two intersecting straight lines can be connected by an infinite number of circles, actually on a highway or railroad the number will be limited by conditions existing on the ground. The circle selected may be described by its radius, or by its degree of curve. This is the angle at the center of the circle, subtended by a chord (or by an arc) of 100 ft. The chord definition is the older one, used in railroad practice and by many highway engineers. Some of the latter prefer the arc definition.

The relations existing between the various parts of the curve shown in Fig. 3 are expressed by the following formulas:

$$R = \frac{50}{\sin\frac{D}{2}} \qquad T = R\tan\frac{I}{2}$$

$$E = T\tan\frac{I}{4} = R\,\mathrm{exsec}\frac{I}{2} \qquad \sin\frac{d_1}{2} = \frac{c_1}{2R}$$

$$c_2 = 2R\sin\frac{d_2}{2} \qquad L\ (\text{approx.}) = \frac{I}{D}\times 100$$

The line is marked on the ground by the station method, described in connection with profile leveling. The first point on the curve beyond the *P.C.* is at a distance $c_1$, usually less than 100 ft. The chord subtends an angle $d_1$. The short chord at the end of the curve, $c_2$, subtends an angle $d_2$. The length of the curve, $L$, is the sum of $c_1$, $c_2$, and the length of the 100-ft. chords making up the rest of the curve.

Points on the curve are most easily located by the method of deflection angles. The transit is set up at the P.C., a pointing is made on the P.I., an angle $d_1/2$ is turned, and the first station is set at a distance of $c_1$ from the P.C. The next point is set at a distance of 100 ft. from this station, and on a line making an angle $(d_1 + D)/2$ with the back tangent. Other points are set in a similar manner, measuring horizontal distances of 100 ft. from the preceding ones, and increasing the total deflection angle by $D/2$ for each new point. The accuracy of the work is checked by comparing the measured and calculated values of $c_2$, and by noting how exactly the last line of sight with a deflection angle of $I/2$ strikes the point previously set to mark the P.T.

Although the computations for the staking out of a circular curve can be made by an application of the formulas listed above, the task is greatly simplified by the use of tables prepared for the purpose and found in most railroad and highway handbooks. These handbooks also contain tables useful in calculating spiral easement curves.

**Spiral Easement Curves.** The equation of the curve used as a spiral easement curve is of the form:

$$x = \frac{l^3}{6R_c l_c},$$

where $x$ is the tangent offset to a point on the curve, at a distance $l$ from the beginning point of the spiral. $R_c$ is the radius of the circle beyond the spiral, and $l_c$ is the length of the spiral.

This easement curve can be staked on the ground by the deflection-angle method. Because the radius varies from infinity to $R_c$, the curve subtends a central angle half as large as would a circular curve of the same length. The deflection angles are one-third of the central angles, and they vary as the squares of the distances from the beginning point of the spiral. From these relations the deflection angles can be computed, or they can be taken from the tables in the railroad and highway-engineering handbooks. One set of such tables is based on the assumption that ten points are to be located on the curve. The handbooks also contain diagrams indicating the proper length of curve required for smooth riding at a given speed around a curve of known radius.

The length selected and the amount of superelevation must be a compromise, since railroads must care for both passenger and freight trains. Highways must provide for both passenger and truck traffic traveling under dry, wet, and icy pavement conditions. Consequently, the amount of superelevation is somewhat less than would be required theoretically for the highest speed travel, and too great for the slower speeds.

**Vertical Curves.** Because of the simplicity of the computations, parabolic arcs are used to connect intersecting

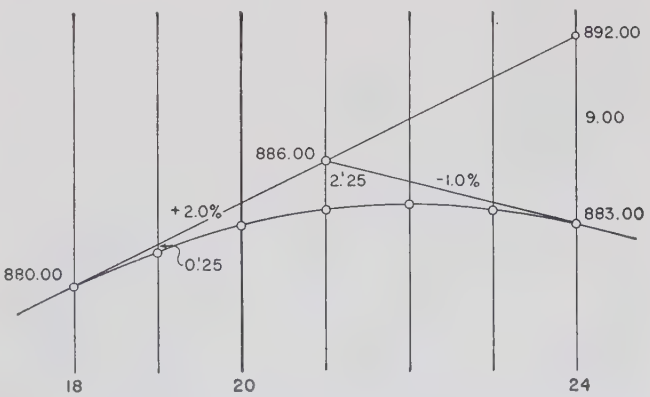



*Fig. 4—SURVEYING A PARABOLIC VERTICAL CURVE*

grade lines. From the properties of the parabola, the horizontal projections of the tangents to a parabola are equal, and the vertical offsets from a tangent to the parabola vary as the squares of the horizontal distances from the point of tangency. The computations for a parabola connecting the two grade lines shown in Fig. 4 are tabulated above. From the indicated rates of grade, the offset at the final Station 24 is computed at 9.00 ft. The offset from the tangent at the first station on the curve is $9.00/(6)^2 = 0.25$ ft.

COMPUTATIONS FOR FIG. 4

| *Sta.* | *Elev. Tangent* | *Offset* | *Elev. Curve* | *Offsets* |
|---|---|---|---|---|
| 18 | 880.00 | 0.00 | 880.00 | |
| 19 | 882.00 | 0.25 | 881.75 | $0.25 \times 1^2 = 0.25$ |
| 20 | 884.00 | 1.00 | 883.00 | $0.25 \times 2^2 = 1.00$ |
| 21 | 886.00 | 2.25 | 883.75 | $0.25 \times 3^2 = 2.25$ |
| 22 | 888.00 | 4.00 | 884.00 | $0.25 \times 4^2 = 4.00$ |
| 23 | 890.00 | 6.25 | 883.75 | $0.25 \times 5^2 = 6.25$ |
| 24 | 892.00 | 9.00 | 883.00 | $0.25 \times 6^2 = 9.00$ |

## MAPS AND MAPPING

**Map Scales.** A map is a graphical representation of a portion of the earth's surface, drawn on a plane to some definite scale. Maps are classed as large-scale when 1 in. on the map represents not more than 100 ft. on the ground. Between 1 in. = 100 ft. and 1 in. = 1,000 ft., the map is intermediate-scale. When 1 in. represents more than 1,000 ft., the map is a small-scale one.

Many maps and charts are plotted to so-called natural scales. These natural scales are represented by ratios. On a 1/20,000 map, one unit on the map represents 20,000 units on the ground. Thus, 1 in. on paper represents 20,000 in. on the ground, 1 ft. represents 20,000 ft., and 1 meter represents 20,000 m. on the ground.

A planimetric map is one that represents only horizontal positions. If vertical relations can also be determined, the map is a topographic one.

**Contours.** The most accurate method of depicting vertical positions is by means of contour lines. A contour line contains all points at the same elevation, and every point on a contour is at exactly the same elevation. The intersection of the surface of a still body of water with the shore represents a contour line. The vertical distance between successive contour lines is the contour interval. This may vary from 1 or 2 ft. on maps of very flat ground, to 20 or 100 ft. on those of rugged terrain. The character of the ground surface can be determined by an inspection of a contour map. Widely-spaced contours indicate relatively flat ground, whereas it is steeper where they are close together. If the lines are evenly spaced, the slopes are uniform. The scale of the map and the contour interval must, of course, be taken into consideration when deciding whether the ground surface is flat or precipitous.

**Stadia Surveying.** The stadia method is used almost universally for locating contours and in filling in detail when a topographic map is being made by ground surveys. By this method, both horizontal and vertical distances can be obtained from the same observations. The telescopes of transits and alidades are equipped with three horizontal cross wires, the upper and lower ones being called the stadia wires. The stadia measurement is made by noting the vertical distance intercepted on a rod between the stadia wires. If vertical angles are measured, differences of elevation can be calculated.

Stadia measurements are based on the similar triangles $ABF$ and $a'b'F$ in Fig. 5. Stadia wires placed at $a$ and $b$ in the telescope appear to intercept a rod at $A$ and $B$. Since rays of light that pass through the principal focus of the objective become parallel to the axis of the telescope, $ab = a'b' = i$, the vertical distance between the stadia wires. The focal length $f$ of the objective is the distance from the lens to $F$, the principal focus. The cross wires and the rod are at conjugate foci of the lens.

From the similar triangles,

$$\frac{R}{f} = \frac{AB}{a'b'} \quad \text{or} \quad R = \frac{f}{i} \times AB ,$$

where $R$ is the distance from the point of focus to the rod and $AB$ is the intercepted distance on the rod, the stadia interval of the telescope is the ratio $f/i$. Most instrument makers attempt to place the stadia wires to make this ratio equal 100, so that the distance from the principal focus to the rod will be 100 times the distance intercepted on the rod. The distance to the center of the telescope will be greater than the observed distance $R$ by an amount $C = c + f$. The value of this stadia constant is usually marked on a card attached to the inside of the instrument box. If it is missing, it can be determined by measuring $c$ and $f$ directly on the telescope.

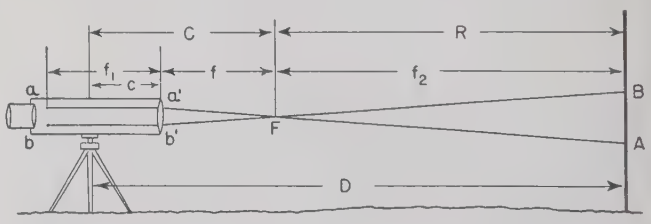



*Fig. 5—THEORY OF STADIA MEASUREMENTS*

Since the cross wires and the rod are at conjugate foci of the objective, $1/f_1 + 1/f_2 = 1/f$. The distance to the rod will be large compared with the length of the telescope, so $1/f_2$ will be quite small, and for all practical purposes $1/f_1 = 1/f$, or $f_1 = f$. The distance $f_1$ from the cross wires to the objective can be measured directly on the telescope, as can $c$, the distance from the objective to the center of the telescope. Their sum will be the constant $C$ for the instrument.

**Inclined Stadia Measurements.** When the line of sight is inclined, a correction must be applied to the observed distance to obtain the horizontal distance. The intercepted distance $AB$ in Fig. 6 will be too great, since the line of sight $ED$ is not perpendicular to the rod. In the triangle $ADA'$ the angle at $A'$ is practically 90°; $A'B' = AB \cos a$.

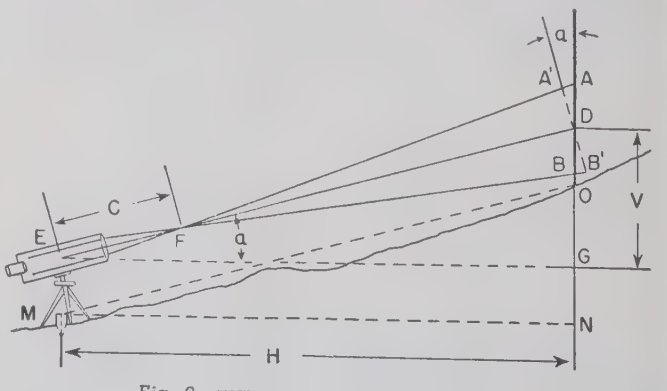



*Fig. 6—INCLINED STADIA MEASUREMENTS*

$ED = f/i \times AB \cos a + C = R \cos a + C$, where $R = f/i \times AB$. In the triangle $EDG$, $EG = H = R \cos^2 a + C \cos a = R - R \sin^2 a + C \cos a$; $DG = V = R \cos a \sin a + C \sin a = R \times \frac{1}{2} \sin 2a + C \sin a$.

When extreme precision is not required, the following formulas can be used:

$$H = R \cos^2 a + C = R - R \sin^2 a + C$$

$$V = R \times \tfrac{1}{2} \sin 2a.$$

If, in Fig. 6, $OD$ is made equal to $EM$ when the vertical angle $a$ is being measured, the triangles $EDG$ and $MON$ are equal, and $ON = DG = V$. Thus, the difference in elevation between the point occupied by the transit and the point where the rod is held is obtained directly.

The corrected horizontal and vertical distances can be calculated by a direct application of the formulas listed above, by means of stadia tables found in most engineering handbooks, by stadia slide rules, or by the use of stadia diagrams.

**Field Procedure.** The first step in a topographic survey is to establish horizontal and vertical control. When a survey is made of a very small area, it may be possible to make all the field measurements from a single position of the instrument. If the area is somewhat larger, the transit or plane-table stations can be connected by a closed traverse, the distance between them being measured by stadia or steel tape, depending upon the required precision. For very large areas, a triangulation network is required. Traverses are run between the triangulation stations to locate the transit or plane-table stations.

Vertical control may consist of a single bench mark or an extensive level network with enough bench marks to permit frequent checks on elevations to be made from the traverse stations. For very accurate work, the elevations of the stations may be determined by spirit leveling.

Contours are located in two ways. The more accurate method is to find points on the ground the elevations of which are those of the required contour. The points are so selected that when they are plotted on the map, a smooth curve drawn through them is an accurate representation of the contour. The points are found by trial in the same manner in which a grade stake is set. The elevation of the transit or level is found by a rod reading on a point of known elevation. The difference between this height of instrument and the elevation of the required contour is the rod reading to be found on the ground by trial. When the point is found, it is located by measuring a horizontal angle and a distance to it from some fixed point. This field procedure is best suited to surveys of small areas or where a small number of contours are to be located. In the second method, interpolation is used when the ground surface is very irregular and when many contours are to be located. In this method, the rodman picks points at which there are breaks in the ground surface. The instrumentman locates the points by reading a horizontal angle, a stadia distance, and a vertical angle to each of them. After the points and their calculated elevations have been plotted on the map, contours are drawn by interpolating along lines that join points between which the ground slopes are uniform.

**Plane-Table Surveying.** The plane table is used to prepare a map in the field where the features can be seen and errors readily detected and corrected. If the survey can be made from a single station, the plane-table board with drawing paper attached is set up, leveled, and oriented so the area to be covered will fall within the limits of the sheet. A point on the board is selected to correspond with the station on the ground, and pointings are made to objects which are to appear on the map and to points to be used in locating the contours. The pointings are made by pivoting the edge of the alidade over the mapped position of the station, and directing the telescope to the rod. The stadia distance and the vertical angle are measured. Without disturbing the alidade, the corrected horizontal distance is plotted along the edge of the ruler, and the calculated elevation of the point is indicated. When a sufficient number of points have been mapped, the corresponding features such as streams, highways, railroads, and buildings are drawn in and the contours are sketched. Because the ground surface is directly before the topographer, he can map the area with fewer located points than is possible when the transit-stadia method is used.

If a larger area is to be covered and more than one station is necessary, the additional stations may be located as the survey progresses. Upon moving to a new station, the alidade is placed along the line connecting the station with a previously occupied one and the board is turned until the line of sight strikes that point. The board is then clamped and its orientation is checked by sighting on another previously located point that is visible from the new station. The area within the limits of this station is mapped and another new station is then located. The work should be conducted so that the plane-table stations form a closed traverse, thus affording a check on the precision of the survey. When large areas are being mapped, errors of closure in the traverses are difficult to distribute. It is preferable, in this case, to establish control by more exact methods, such as triangulation or taped transit traverses. This control is plotted on the plane-table sheet before taking it into the field.

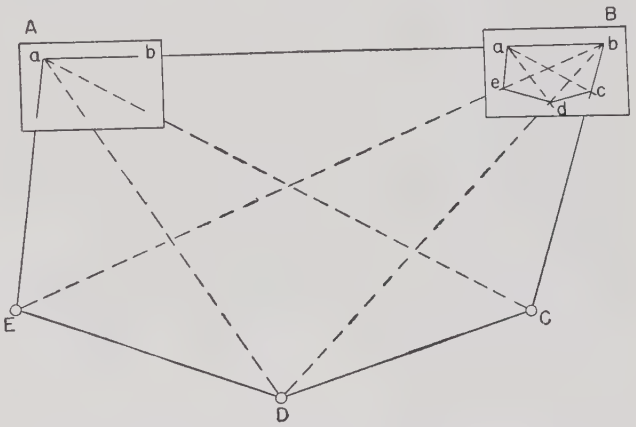



*Fig. 7—The principles of intersection, by means of a plane table*

**Method of Intersection.** The principles of intersection are shown in Fig. 7. In this example the board is set up at Station $A$ and oriented. Station $B$ is located by sighting to it and measuring the distance $AB$. From $A$, pointings are made on points $E$, $D$, and $C$, and lines are drawn on the map to indicate their directions. The board is then moved to Station $B$ and oriented by backsighting on Station $A$. Sights are again taken on points $E$, $D$, and $C$. The mapped positions of these points are at the intersections of the lines from Station $B$ with those drawn from Station $A$. These points may represent additional plane-table stations to be occupied later, or they may be points difficult or impossible of access by a rodman. Their elevations can be calculated by measuring vertical angles to them, and by scaling from the map the horizontal distances to them. The difference in

elevation is the product of the horizontal distance and the tangent of the vertical angle.

**Three-Point Problem.** An additional advantage of the plane table is the ease with which the three-point problem can be solved. If, in Fig. 8, points *A*, *B*, and *C* are visible from a point *P*, and if these points have previously been plotted on the plane-table sheet, the plotted position of *p* can be determined and the board properly oriented.

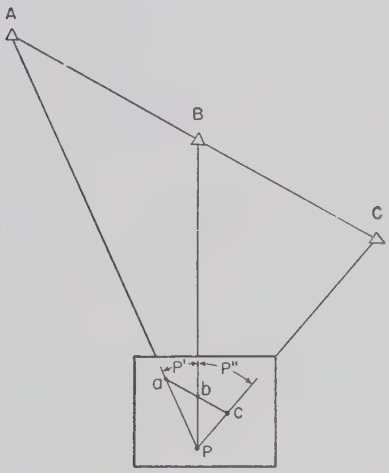



*Fig. 8 — SOLUTION OF THE THREE-POINT PROBLEM*

A mechanical solution of the problem requires a piece of tracing paper. This is placed on the plane-table board, and from any convenient point on it radial lines are drawn in the directions of the three points *A*, *B*, and *C*. The paper is then shifted until the line toward *A* passes through *a* on the board, the one through *B* passes through *b*, and the one through *C* passes through *c*. The intersection of the three lines is then directly above *p* on the board, and its position can be marked by pricking through the transparent paper to the map below. The board is then oriented by placing the alidade along the line *pa*, *pb*, or *pc* and rotating the board until the line of sight passes through the corresponding point on the ground. The orientation can be checked by sighting at either of the other two points.

The point *p* can also be determined by trial. After the board has been oriented by estimation, the alidade is pivoted over *a*, a sight is taken on *A*, and a line is drawn along the edge of the alidade. It is next pivoted over *b*, a sight is taken on *B*, and a line is drawn to intersect the first one. If the board has been correctly oriented, the line through *c* with the alidade pointing on *C* will intersect the first two lines in the same point. If not, as is generally the case, a triangle will be formed. From the size and shape of this triangle it is possible to estimate the approximate amount the board should be rotated. Successive trials are made until this triangle of error is reduced to a point.

The three-point method of location is valuable when areas on both sides of a stream are being mapped and where it has not been convenient to locate in advance a station on the opposite bank. It also affords a means of orientation when an older map is taken into the field for checking or revision.

## GEODESY

**Definition and Scope.** Geodesy is that branch of surveying which takes into account the size and shape of the earth. The work includes the determination of the size and shape of the earth as well as the exact position of points on its surface. These tasks require astronomical observations for time, latitude, longitude, and azimuth; triangulation, including the measurement of the force of gravity, terrestrial magnetism, and the deviation of the plumb bob; leveling; and sounding of oceans, lakes, and rivers, which in turn necessitates the determination of mean sea level, and a study of tides and currents. These measurements are subject to certain unavoidable errors. After all known errors have been eliminated, the method of least squares is used to determine the most probable values of the observed quantities.

**Triangulation.** If the length of one side of a triangle and at least two of its angles are known, the lengths of the other two sides can be computed. In geodetic work, most lengths are obtained in this manner, since direct measurement by taping would be too laborious. Long belts of triangulation, consisting of connected quadrilaterals, have been carried across the country. Although positions could be calculated if connected triangles were used, there would be fewer checks on the precision of the work. For this reason, quadrilaterals, or figures with a common center point, are used, and all angles are obtained by observation. At intervals, a side, called a base line, is measured on the ground.

*Classes of Triangulation.* Triangulation is classed as first, second, third, or fourth order according to its precision. Certain specifications have been set up to test this precision. As an example, in first-order work, the sum of the three angles of a triangle should usually be within 1″ of the theoretical 180°, and never more than 3″ in error. The corresponding values for fourth order are 12″ and 30″. The actual error in the length of a first-order base line should not exceed 1 part in 300,000, and the probable error should not exceed 1 in 1,000,000. The fourth-order values are 1 in 25,000 and 1 in 100,000. A further test is to compare the computed length of a check base line with its measured length. For the first-order precision, the discrepancy should not exceed 1 in 25,000. For fourth-order work, 1 in 2,500 is allowable. *See also* COAST AND GEODETIC SURVEY, UNITED STATES; MAPS AND CHARTS; PHOTOGRAMMETRY. H. Bo.

**SUSA,** a famous ancient city of western Asia and the capital of Elam. Susa is mentioned in Biblical narrative as Shushan, the "city of lilies." A stele found there and dating from late in the third millenium B.C. records the victories of Naram Sin, King of Akkad. The city was captured by the Persian king Cyrus in the sixth century B.C., and Darius I made it the capital of Persia, building there a great palace. The Royal Road, 1,500 mi. long, ran from Susa to Sardis in Lydia. Susa, along with the rest of Persia, fell to Alexander the Great, and under the Seleucid kingdom the city was known as Seleucia-on-the-Eulaeus; although later subject to Parthia, it long remained within the sphere of Greek culture. The ruins of the palace of Darius are most impressive, and a great number of inscriptions and friezes have been found there. G. E. D.

**SUSANNA, HISTORY OF,** a book of the Apocrypha. It is found only in the Greek Bible and in versions based on it. Constituting an addition to the Book of Daniel, it precedes the first chapter of that book in most manuscripts in which it appears; in the Vulgate it is appended to the end of the Book of Daniel. Many critics suppose that the book was originally written in Aramaic rather than in Greek, but opinion is divided on this point.

The story of Susanna takes place in Babylon in the early days of the captivity. Susanna, the beautiful and virtuous wife of Joakim, is spitefully accused of adultery by two elders who had failed in their attempts to seduce her, and on

the strength of their testimony she is condemned to death. Convinced of her innocence, however, Daniel, then a young man, cleverly exposes the falsity of the accusation by cross-examining each of the elders separately.

The History of Susanna was probably composed in the early part of the first century B.C. Bible critics do not regard the story as historical, but some see it simply as an additional Daniel legend, while others believe that it was written, in a period of legal reform, to demonstrate the necessity for thorough cross-examination of witnesses. D. G.

**SUSARION** [susɛ′əriən], Greek comic poet supposed to have lived in the sixth century B.C., shares with other claimants the reputation of having invented comedy as a literary form. According to most ancient sources, he came from Icaria in Attica; a late Byzantine story that he was a Megarean may have arisen from the tradition that comedy originated in Megara. The one fragment preserved from his work is of doubtful authenticity: according to the story Susarion entered the theatre, when his wife deserted him, and recited the following verses: "Hear ye, O people: thus speaks Susarion: Women are a nuisance. But still, my neighbors, one cannot keep house without a nuisance." From such impromptu utterances comedy was supposed to have taken its origin. Many have doubted that Susarion ever existed.
C. T. M.

**SUSQUEHANNA.** *See* INDIAN TRIBES, NORTH AMERICAN (*Eastern Woodland*).

**SUSQUEHANNA RIVER** [sʌskwəhæ′nə], the largest river of Pennsylvania, 444 mi. in length. It rises in Otsego Lake, northeast of Cooperstown, Otsego Co., east central New York State, and flows southwestward into Chenango Co., N. Y., where it bends southward into Susquehanna Co., northeastern Pennsylvania. The river then bends northwestward into south central New York State, where it turns to the south again and flows into Bradford Co., Pa. After flowing southeastward to a point near Pittston, Pa., the river bends to the southwest and eventually joins the West Branch of the Susquehanna just to the north of Sunbury, in east central Pennsylvania. The headwaters of the West Branch rise in Indiana Co., west central Pennsylvania, and the river flows generally northeastward to Lycoming Co., where it bends to the south to join the Susquehanna proper. The West Branch of the Susquehanna is 160 mi. long. From Sunbury, the Susquehanna River flows southward and southeastward across Pennsylvania and into northeastern Maryland, where it enters Chesapeake Bay near Havre de Grace, Md.

Before the Ice Age the Susquehanna drained most of central New York State, but the ice deposited a moraine across the state and the northern tributaries of the Susquehanna were blocked and formed the Finger Lakes. The North Fork and West Branch were formerly separate rivers, but tributary streams of the West Branch captured the North Branch, diverting the water into the course of the West Branch. Between Sunbury and Harrisburg, Pa., the Susquehanna has cut five water gaps across the Appalachian.

The Susquehanna is a shallow, rapid stream that becomes a raging torrent in late winter. The North Fork falls 1,923 ft., while the West Branch falls 688 ft. The Susquehanna flows through the Scranton-Wilkes-Barre anthracite coal-mining and industrial sections. The most important cities on the river are Binghamton, N. Y., and Pittston, Wilkes-Barre, Harrisburg, and Lancaster, Pa. From the mouth of the Susquehanna there is a submarine channel that extends eastward across the continental shelf. J. E. F.

**SUSQUEHANNA UNIVERSITY,** an accredited, co-educational college of arts and sciences, affiliated with the United Lutheran Church in America. It occupies a 62-acre campus in Selinsgrove, Pa. It was chartered as the Missionary Institute of the Evangelical Lutheran Church in 1858 and first instruction was given that same year. The present name was adopted in 1924, when the institution was changed from a two-year to a four-year college. The degrees offered include the A.B., the B.S., and the B.Mus. Courses are offered in teacher training and in business education. Some undergraduate scholarship aid is offered and some opportunity for self-help. Dormitories are available for both men and women. *For statistics see* COLLEGES AND UNIVERSITIES.
J. R. To.

**SUSSEX,** a maritime county in southeastern England, with an area of 1,457 sq. mi. It is bounded by the counties of Surrey and Kent on the north, Hampshire on the west, and by the English Channel on the east and south. The chalk uplands of the South Downs extend from the Hampshire border along the coast as far as Beachy Head. North of the Head is the Weald valley, from which the surface rises to a forest ridge in the northeast and sinks toward the sea in the southeast, where there are wide marshes. Sussex is divided into the administrative counties of East Sussex and West Sussex. At Lewes the assizes for the whole county sit, as does the county council for East Sussex, but the county council for West Sussex is at Chichester, a cathedral town which still shows traces of its Roman origin. The most fertile soil is near the coast, where grain and hay are raised. The South Downs are pastoral and have given their name to a breed of sheep. Hops are grown in the eastern part of the county. Ironstone is abundant. Woolens, paper, gunpowder, and bricks are manufactured. The Weald, once densely forested, is now denuded and is used as a pasture. There was an important iron industry on its heights in the sixteenth and seventeenth centuries. Hastings was one of the Cinque Ports—that is, the five great ports on the southeastern coast. The Battle of Hastings, 1066, was fought about seven miles northwest of the town. Rye and Winchelsea were "Ancient Towns," sharing the privileges and duties of the Cinque Ports. Brighton is the largest and most widely known seaside resort in England. Christ's Hospital, West Horsham, is the famous Blue Coat School, where the students still wear the ancient costume with blue gowns. Charles Lamb, Samuel Coleridge, and Leigh Hunt were among its graduates. The county returns seven members to Parliament. Pop. 1954, 937,200.
S. Van V.

*Pevensey Castle, Sussex, one of the remaining Norman ruins of the area*

THE TRAVEL ASSOCIATION

**SUSSEX,** a town in Kings Co., New Brunswick, Canada, situated in the valley of the Kennebecasis River, 40 mi. northeast of St. John on Provincial Highway 2. Sussex is served by the Canadian National Railways. It lies in the midst of one of the better agricultural districts of the province, noted for its dairy cattle. Pop. 1951, 3,224. D. F. P.

**SUSSEX SPANIEL.** *See* Dog.

**SUTHERLAND** [sʌ'thərlənd], a maritime county of northern Scotland with an area of 2,028 sq. mi. It extends from sea to sea, bounded on the west and north by the Atlantic Ocean, on the east by Caithness and the Moray Firth, and on the south by Dornoch Firth and Ross and Cromarty. The county is mainly mountainous, with heaths and bogs, trackless deer forests, and barren grouse moors. It has a larger proportion of surface covered with water than any other Scottish county. Ben More Assynt, the county's highest peak, rises to 3,273 ft. There are extensive coast fisheries. The dukes of Sutherland are the principal landowners. At the Sutherland Clearances of 1810-1820 about 15,000 peasants were moved from the crowded interior crofts to crofts on the coast. Sutherland unites with Caithness to send one member to Parliament. It is the most sparsely populated county in Scotland. Pop. 1954, 13,519. S. Van V.

**SUTHERLAND FALLS,** the highest waterfall in New Zealand, 1,904 ft. in height, and one of the highest waterfalls in the world. The falls are located in the mountainous southwestern part of South Island and are formed by a stream, the outlet of a small glacial lake, which plunges over a high precipice to the floor of the Arthur Valley. The Arthur River empties into Milford Sound, formed by one of the many indentions of the western coast of the island. R. G. B.

**SUTTER, JOHN AUGUSTUS** (1803-1880), American pioneer, was born in Kandern, Baden, Germany, in February 1803. He passed his early years in the village of Ruenenberg, Switzerland, and attended a military school at Neuchatel. He served in the Swiss army and, in 1834, emigrated to America; he may have lived for about a year at St. Charles, Mo. In 1835 and 1836, he traveled in the southwest, and in 1838 he went to Oregon. From there he sailed south to San Francisco Bay, in July 1839, and four days later, at Monterey, he presented to the Mexican governor, Juan Bautista Alvarado, a project for establishing a colony on the unexplored frontier at the north. He selected a tract on the site of the present city of Sacramento, Calif., where he constructed a fortified post that he named Nueva Helvetia. In 1841, he received a formal grant from the Mexican government of this tract, of between 100 and 150 square miles, and became that year a Mexican citizen. In 1849, he was a delegate to the Constitutional Convention of the new state of California and a candidate for governor at the first election. Meanwhile, on Jan. 24, 1848, gold was discovered on his property. In the California gold stampede of 1848 and 1849, his workers deserted him and his flocks and herds were stolen. In 1852, he was bankrupt. Seven years before he had been the owner of a vast estate and the virtual ruler of an independent domain. The remaining years of his life were spent in futile efforts to recover these lost properties. He died at Washington, D. C., June 18, 1880. A. W. Gr.

**SUVA** [su'və], the capital of the Fiji Islands, a British colony in the south Pacific Ocean. Suva is located at 18° 8′ S. lat. and 178° 25′ E. long. on the southern coast of Viti Levu Island. The city is 2,740 mi. south southwest of Honolulu, Hawaii, and 1,743 mi. northeast of Sydney, Australia. Suva is noted for its beautiful harbor, one of the best in the South Pacific. Suva has a tropical oceanic climate with year-round temperatures averaging between 70° and 80° F. The capital of the Fiji Islands was transferred to Suva from Levuka, on the island of Ovalau, in 1882, and since that time Suva has developed rapidly. During World War II Suva was a valuable base and port of supply. Pop. 15,000. R. G. B.

**SUWANNEE** [suwɔ'ni; swɒ'ni], one of the largest rivers in the southeastern part of the United States. The Suwannee, 190 mi. long., is formed by the junction of the North and Log rivers in Charlton Co., Ga. From this point it flows southwestward to the Florida boundary at Bounts Ferry, then flows nearly due south, loops westward, and resumes its southern course to empty into the Gulf of Mexico at Suwannee Sound, located about 12 mi. north of Cedar Keys. The Suwannee receives a number of small tributaries. In its upper reaches, the river has a fairly steep gradient and flows swiftly in a relatively narrow valley, hemmed in by high wooded banks, but further downstream it widens and flows through a broad flood plain. During the eighteenth and nineteenth centuries, the Suwannee was of considerable importance as an outlet for cedar logs floated downstream and later carrying considerable steamer traffic. At the turn of the century, however, river traffic ceased as a result of railroad competition. The importance of the Suwannee today for most Americans lies probably in the fact that it is mentioned in Stephen Foster's "Old Folks at Home." A. L. R.

**SVALBARD** [svɑ'lbɑr], all the Norwegian island possessions in the Arctic north of Norway, between 74° and 81° N. lat, and between 10° and 35° E. long., including the islands and island groups of Spitsbergen, Bjørnøya (Bear Island), Hopen (Hope Island), Kong Karls Land, and Kvitøya, with a total area of about 24,500 sq. mi. Spitsbergen, the principal group, comprises five major islands and many smaller ones; it measures approximately 250 mi. both from north to south and from east to west, between 76° and 80° N. lat., and has a total area of 24,200 sq. mi. Vestspitsbergen, the largest island, has nearly 15,000 sq. mi. Nordaustlandet (North East Island), to the northeast, about 6,000 sq. mi.; Barentsøya (Barents Island), to the east, 580 sq. mi.; Edgeøya (Edge Island), south of Barentsøya, 2,500 sq. mi.; and Prins Karls Forland, to the west, about 300 sq. mi. The topography of the group is highly broken with the pointed mountain peaks (*spitsbergen*) for which it is named; of these, Newton Peak (5,676 ft.), on Vestspitsbergen, is the highest. Much of the surface of the larger islands is covered with tremendous glaciers which reach down to the ocean, where their ice breaks off (calves) into icebergs. The coasts are indented by deep fjords; Isfjorden, the longest, extends 60 mi. into the western part of Vestspitsbergen. The rivers, rushing in the summer, when the snow lying at elevations up to 1,600 ft. melts, are of little importance, since the greater part of the limited precipitation (about 10 in. annually) reaches the sea in the form of glacier ice. The vegetation is of the tundra type, principally mosses, with some 130 species of flowering plants and a few dwarf trees. The climate is arctic, with winter temperatures of —10° to —40° F. and summer temperature of 40° to 45° F.

The islands are part of the belt of mountains folded in the Silurian-Devonian and extending in a great arc from Scotland to Greenland. Bordering this belt of Paleozoic metamorphic rocks are two north-south belts of Archean

and Cambrian rocks. This complex of rocks was eroded to sea level in Tertiary time and later uplifted to 2,000 to 3,000 ft. where the flat plateau surface, or peneplain, is now found. During the Pleistocene the great plateau glaciers were formed, the remnants of which still exist.

Spitsbergen, discovered by the Norsemen in 1194 and rediscovered in 1596 by the Dutch navigator Willem Barents, was the scene of extensive whaling and sealing operations during the eighteenth and nineteenth centuries. The whales have become exterminated and the seals are greatly reduced in number, as are the native walruses, polar bears, reindeer, and foxes. Various birds, including the eider duck and gulls, frequent Svalbard, but only the ptarmigan and the snowy owl stay there throughout the year.

Coal has been mined commercially since 1899, when an American company began to exploit the Tertiary coal found to the south of Isfjorden. Its settlement, Longyear City (called Longyearbyen since 1916, when the mine passed to Norwegian ownership), is the largest in Svalbard, with a population of about 1,000. Another thousand or more miners live at other settlements, among them Ny Ålesund, Hiorthomn, Barentsburg, and Calypsobyen, all on the west coast of Vestspitsbergen, and Tunheim, on Bjørnøya. There is no native population. Shipments of coal totaled 336,500 long tons in 1947 and 422,785 long tons in 1948.

Prior to 1920 the islands had been without sovereignty, but in that year they were assigned to Norway by international agreement. This sovereignty, which excludes the fortification of the islands and guarantees equal opportunities to signatories of the treaty to engage in the islands' economic exploitation, was made operative on July 17, 1925. Many of the coal mines are worked by the Soviet government, to which, in accordance with the treaty, the Norwegian government refused to grant military bases at the end of World War II. J. E. V.

**SVANETIAN.** *See* Asiatic Tribes (*Other Linguistic Families*).

**SVENGALI** [svɛngɑ′li], the villain of George du Maurier's novel, *Trilby,* who is celebrated for his power of hypnosis. While under his spell, the unskilled heroine, Trilby, is transformed into a great singer. Hence, in general usage, a "Svengali" is a person who imposes his will and plans upon a weaker person. H. H. Wa.

**SVERDLOVSK** [svyɛrdlɔ′fsk], the name of both a governmental region and the city that is the administrative seat of that region, located in the Russian Soviet Federated Socialist Republic, in the west central Soviet Union.

**The City.** The city of Sverdlovsk was called Ekaterinburg prior to 1924. It is an industrial and mining center, located on both banks of the Iset River, near its source, in the eastern foothills of the middle Ural Mountains, about 190 mi. southeast of Molotov, at 57° 5′ N. lat. and 60° 30′ E. long. Founded by Peter the Great in 1721 and named after his wife Catherine I, it rapidly became a mining and trading center. It became especially famous for its cutting of gem stones. It figured significantly in the civil war between 1917 and 1921, and Tsar Nicholas, his wife, and five children were executed in a cellar there in July 1918. Under Soviet five-year plans it expanded enormously and developed further during World War II. It is a well-built city with wide streets and has two cathedrals and an old mint. Sverdlovsk possesses a state university, institute of medicine, institute of forestry, several repertory theatres, and numerous other educational and scientific institutions. It is the junction for seven important rail lines and is a distributing point for machinery and industrial raw materials. It is located in the rich Urals mineral area, and the local populace engages in the mining of gold, platinum, iron, manganese, bauxite, and asbestos. As the center of this great industrial area, which from 1925 to 1945 was made one of the world's largest, Sverdlovsk has a large variety of important industries. Products include steel, turbines, rolling stock, refined aluminum, electrical equipment, heavy machinery, roller bearings, rubber products, plastics, paper, refined copper, lathes, chemicals, machine tools, textiles, mining machinery, and precision instruments. Pop. (est. 1954), 750,000. C. C. H.

**The Region.** The Sverdlovsk Oblast (Region) adjoins the Khanty-Mansy National Okrug on the north and east, the Tyumen Oblast on the east, the Kurgan and Chelyabinsk oblasts and the Bashkir Autonomous Soviet Socialist Republic on the south, and the Molotov Oblast on the west. Its area of 74,556 sq. mi. was organized in 1934. Although the Central Urals, attaining a height of only 980 ft., level themselves out in the Sverdlovsk Oblast so that the terrain is an open one of wide valleys, emphasis is less on agriculture than on industry. Approximately 60 per cent of the total population in 1939 lived in cities, making the region one of the Soviet's most urbanized. The reason for this is the wealth of mineral resources either found in the region or easily accessible to it through the network of railroad lines which focuses on the city of Sverdlovsk. Copper ore is excavated at Pyshma and processed at Krasnouralsk and Revda; important sulphur works are found in Kirovgrad; bauxite occurs at Serov (formerly Nazhdedinsk); gold at Berezovsky; platinum at Nizhniy-Tagil; and coal at Ivdel, Alapayevsk, Serov, Kushva, and Nizhniy-Tagil. Fifty-eight per cent of the region is forested, supporting a lumber industry which is centered in Tavda, Novaya Lyalya, and Turinsky. In the valleys of the Tavda, Lozva, Pelym, Tura, and Iset rivers high yields of rye, wheat, and oats are secured. Cattle-breeding is increasing in importance. Although most of the population is Russian, a sizable minority of Germans is to be found, for it was here that the residents of the German Volga Autonomous Soviet Socialist Republic were transported in 1941-1942. Pop. (est. 1954), 3,500,000. W. S. V.

**SWABIA** [swe′biə], a stem duchy of medieval Germany. Deriving its name from the Suevi, it was situated in the valleys of the upper Rhine and the Neckar and around Lake Constance. Settled by various German tribes besides the Suevi, it was for a long time called Alamannia. It became a duchy of the Frankish kingdom after its conquest by Clovis in 496 but had to be reduced again by Charles Martel in 730. Swabia was ruled by the counts of Raeti until 917, when Count Burkhard took the title of duke, later receiving recognition from Henry the Fowler. On Burkhard's death in 926, a Franconian noble named Herman married his widow and secured the duchy. Herman died in 948 and Otto the Great gave the duchy to his son Ludolph, who later revolted and was deposed. After a succession of dukes, Swabia was given by Henry IV to Count Frederick of Hohenstaufen (1079), and it remained under Hohenstaufen control until the extinction of the line in 1268. Subsequently, the duchy fell apart into such states as Württemberg, Baden, and Hohenzollern. F. C. H.

**SWABIAN LEAGUE** [swe′biən], several associations of Swabian cities, nobles, and prelates in southwestern Germany, beginning in the fourteenth century, formed for re-

gional peace and the protection of commercial interests. In 1331, Ulm, Augsburg, Heilbronn, and nineteen other cities formed a league at the instance of the emperor, Louis IV of Bavaria, who wanted their support. Following defeat of the league in 1372, in 1376 a new federation of fourteen Swabian cities was formed for protection of their interests against the feudal nobles and the emperor Charles IV. Growing rapidly in numbers, the league maintained a large armed force and waged war with the opposing leagues of nobles. Peace was made after the defeat of the cities in 1388, and the leagues were dissolved.

A century later, in 1488, another Swabian League was formed to maintain order in the weak German empire. Many cities, nobles, and churchmen joined, with the approval of the emperor. The league had a formal constitution, a court, and a large army, which was used to support imperial reform. It restored order in Swabia, successfully opposed the aggressions of the dukes of Bavaria and Württemberg, and aided the Hapsburgs in putting down the revolt of the knights in 1523 and of the peasants in 1525. The league was dissolved early in 1534, due in part to internal divisions resulting from the Protestant Reformation. Later attempts made to renew it proved futile. F. C. H.

**SWALLOW,** any one of a large number of species of songbirds united in the family Hirundinidae. They occur in temperate and tropical regions virtually throughout the world. They are characterized by slender bodies, long, pointed wings, large mouths for capturing insects in flight and small, weak feet; the most typical swallows have deeply forked tails. The majority of them vary in size between 5½ and 8 in. Their plumage combines in various ways such colors as black, white, rufous, metallic blue, and metallic green. Owing to a similar mode of life, they have developed many characteristics in common with the swifts, to which they are not at all closely related; they fly, however, with a slower wing beat, rarely soar, and, despite their weak feet, frequently perch on wires and trees. The voices of swallows are twittering and unmusical. Their breeding habits are exceedingly variable: some nest in burrows or in crevices of stone walls, some in hollow trees; others breed under the eaves of buildings; still others affix retort-shaped structures of dried mud to such vertical surfaces as walls and cliffs. No less than nine species of swallows are known in the United States; of these, perhaps the best known are the barn swallow and the purple martin. H. G. De.

*THE TREE SWALLOW*

HAL H. HARRISON

**SWALLOWTAIL,** the name given to any butterfly of the genus *Papilio,* which includes most of the members of the family Papilionidae. The genus is a moderately large one, with most of its members occurring in the tropics. The swallowtails are divided into several distinct groups which are more or less associated with their feeding habits. In eastern North America, the best known species are the tiger swallowtail, *Papilo glaucus,* or *turnus,* which feeds on cherry and related plants; the parsley swallowtail, which feeds upon carrots and related plants; and the spicebush swallowtail, which feeds on sassafras, spicebush, and laurel. *P. daunus,* of the West, also feeds on cherries and related plants. The caterpillars of some species have eye-like spots on the thorax, and some possess a pair of extensile, tentacle-like scent organs which they extrude when disturbed. The orange dog is the caterpillar of *P. cresphontes,* the orange-tree swallowtail. The family includes the birdwing butterflies of New Guinea, the males of which have very narrow wings and the females of which are among the largest of all butterflies. These are sometimes placed in a separate genus, *Ornithoptera.* C. H. Cu.

**SWAMMERDAM, JAN** [svɑ'mərdɑm] (1637-1680), Dutch naturalist and biologist, born at Amsterdam, Feb. 12, 1637. He was the son of an apothecary, who had collected a museum of curiosities. He helped his father, entered the university of Leyden at 24, studied medicine and obtained his doctor's degree in 1667. He abandoned medicine for zoology, visited Paris and drew the attention of scientists by his skill in dissection. On his return he published *Algemeene Verhandeling von bloedloose diertjens* ("General Account of Bloodless Animalculae"—Utrecht, 1669; French and Latin versions, 1685), which deals with metamorphosis of insects. The text and illustrations won popular recognition, particularly because of the minuteness of observation and intelligent presentation. In 1664 he discovered the valves of the lymphatic vessels. Swammerdam observed and described (1658) blood corpuscles in the frog. He traced the development of the frog and made fine dissections of the tadpole. Swammerdam demonstrated by an experiment that when muscles contract they alter in form but not in size. He studied infections and the movement of the heart and lungs. He improved the technique of injection; and one of his early publications threw some light on respiratory processes. He depicted the sporangia of ferns and investigated the anatomy of the May fly, the bee, the snail, and other forms. He came under the influence of a religious fanatic and suffered fits of depression. In this state he wrote *Ephemerae vita* (Amsterdam, 1675) containing examples of minute anatomy of the May fly. He bequeathed his drawings and manuscripts to Thevenot. On Thevenot's death they were sold by his heirs. His *Biblia Naturæ* ("Bible of Nature") was published in 1737-1738 with plates in two folios. Swammerdam died at Amsterdam Feb. 15, 1680. D. D. M.

**SWAMP LILY,** a handsome perennial, *Crinum americanum,* of the lily family, bearing several creamy-white to greenish flowers on an erect stalk about 2 ft. high. The leaves are 2 to 4 ft. long and are curved and narrow; the whole plant rises from a thick-coated bulb. The swamp lily is also called the St.-John's-lily and is sometimes grown for ornament, but it is native to river swamps from Florida and Georgia westward to Louisiana. M. G. W.

**SWAMP PINK,** *Helonias bullata,* a rare and attractive member of the lily family, inhabiting acid bogs of the coastal plain from southern New York perhaps as far south as

Virginia. It grows as high as 2 ft. The small pink flowers, which have blue anthers, are borne in a dense terminal raceme. They are hyacinth-scented. Increasing readily under favorable conditions, the swamp pink is one of the most desirable of plants for northern bog gardens. C. H. Wo.

**SWAMPSCOTT** [swɒ′mpskət], a town in northeastern Massachusetts, situated in Essex Co., on Massachusetts Bay, between Lynn on the southwest and Marblehead on the northeast, 12 mi. north of Boston, of which it is a suburb. Founded in 1629, Swampscott was incorporated as a town in 1852. The local government is the representative-town-meeting type. Two features of special interest are the Mary Baker Eddy House, where the founder of Christian Science began her demonstrations of healing; and the Humphrey House, built about 1635 and the home of the deputy governor of the Massachusetts Colony. Swampscott is supplied with transportation by the Boston and Maine Railroad. Commercial fishing is an important industry of the city. Pop. 1950, 11,580.

**SWAN, SIR JOSEPH WILSON** (1828-1914), English engineer and inventor, was born in Sunderland, Durham, Oct. 31, 1828. He had little formal education and was apprenticed early to a firm of chemists. He later joined another chemical firm, introduced new manufacturing processes, and in 1860 became a partner. In 1864 Swan developed the "autotype" carbon process, the first practical means for making permanent photographs. At the same time he developed a leather-curing process that became the basis for modern tanning methods. In 1877 he developed sensitive dry-gelatin plates and two years later bromide photographic-printing paper. Swan's work with electric bulbs led him to devise a longer lasting filament; this he did by treating ordinary crocheting cotton with sulphuric acid and then carbonizing it. Further experiments showed that the life of the filament depended to a considerable extent on the vacuum it burned in. The mercury pump invented in 1865 by Herman Sprengel achieved a superior vacuum and with it Swan produced a carbon-filament incandescent lamp in 1879. He also invented the miner's electric safety lamp. Swan was knighted in 1904. He died in Warlingham, Surrey, on May 27, 1914.
S. M. M.

**SWAN,** any one of five species of very large, long-necked, web-footed birds united in the genus *Cygnus;* they are closely allied to the geese. Three species breed in subarctic and temperate regions of the Northern Hemisphere; the others are restricted to Australia and southern South America. The plumage of the northern species is all white; the Australian swan is black with white wing patches, and the South American bird is white with a black neck. Male swans are known as cobs; the young are called cygnets. Most swans are famous for their loud, resonant voices. The mute swan, *C. olor,* is exceptional in being able to produce only hissing sounds. Of the two native North American species, the trumpeter swan, *C. buccinator,* has become extremely rare and restricted to a small number of breeding places in the western part of the continent, but the whistling swan, *C. columbianus,* is increasing in numbers under protection. The semidomesticated mute swan has been imported from Europe and is a familiar bird on park lakes. The trumpeter swan measures 5 ft. long and the whistling swan measures 4½ ft. H. G. De.

HAROLD M. LAMBERT FROM FREDERIC LEWIS

*Swan, constituting the subfamily Cygninae of the duck family*

**SWAN LAKE (LE LAC DES CYGNES)** [lə la′k de si′ny], a ballet to a score by Pyotr Ilyich Tchaikovsky. An unsuccessful version, with choreography by Julius Reisinger and with much of Tchaikovsky's music discarded in favor of conventional dance tunes, was presented at the Bolshoi Theatre, Moscow, on Mar. 4, 1877. In 1894 Marius Petipa sketched out a new version, for which the actual staging was done by Lev Ivanovich Ivanov. The second act was presented at the Maryinsky Theatre, St. Petersburg, on Feb. 29, 1894, and the entire four acts on Jan. 27, 1895.

Recent custom presents Act Two as a separate ballet. The *pas de deux* from Act Three, featuring the thirty-two *fouettés* made famous by Pierina Legnani in the first performance, is frequently presented separately as the *Black Swan Pas de Deux.* The full-length *Swan Lake* remains in the repertories of the English and Russian ballet companies. F. G. P.

**SWANSEA** [swɒ′nsi; swɒ′nzi], a residential suburb of Toronto in York Co., Ontario, Canada, along the Humber River. It was incorporated as a village in 1925. Large steel and clay products plants are located at Swansea. Pop. 1951, 8,072. D. F. P.

**SWANSEA,** a municipal, county, and parliamentary borough, railroad junction, and seaport of Glamorganshire, Wales, situated at the mouth of the Tawe River, on Swansea Bay, about 35 mi. northwest of Cardiff, in a coal-mining region. Henry de Beaumont conquered the area in 1090 and founded, at the end of the eleventh century, the castle around which the town developed. William de Braose granted the community its first charter in the last quarter of the twelfth century. Swansea, which became a parliamentary borough in 1832 and a county borough in 1888, returns two members to Parliament. The original castle, erected by De Beaumont, was destroyed in 1260, and was rebuilt by Bishop Gower. During the eighteenth century, coal was dug near Swansea and the first copper-smelting works were built in 1717. The Swansea Canal was opened in 1798, the Tawe was dammed in 1838, and the first of Swansea's docks was constructed in 1847. In 1850, the railroad was built. East of the Tawe, Swansea is one of the world's most important smelting centers, working in industrial and precious metals. Consequently, the city was heavily bombed in World War II. West of the river is the residential section and beach resort of Oystermouth, or Mumbles, where the remains of a castle, dating from the thirteenth or fourteenth century, are located. University College of Swansea is the newest of the four composing the University of Wales, and its departments of metallurgy and engineering are closely affiliated with the industries of the district, which include plants for copper refining, processing precious metals, manufacturing tinplate, steel plates, bars and tubes, superphosphates and patent fuel, and

the distribution centers for anthracite and oil. Pop. 1954, 160,400. S. Van V.

**SWAN THEATRE.** *See* ENGLISH PLAYHOUSES.

**SWARTHMORE COLLEGE** [swɔ′rthmor], an accredited, coeducational, privately controlled institution founded by members of the Society of Friends, but not now controlled by that Society. It is situated on a 250-acre campus in Swarthmore, Pa. The Bartol Foundation for Research in the Physical Sciences, located on the Swarthmore campus, is under the control of Franklin Institute. Degrees offered are the A.B. in liberal arts, the B.S. in various engineering curricula, and the M.A. The extensive library houses many important special collections, including the Friends historical library, the Jane Addams collection of documents dealing with efforts toward peace; and British Americana. Co-operative arrangements exist with all libraries in Philadelphia and the vicinity. The local chapter of Phi Beta Kappa was established in 1896.

Dormitories and dining halls are provided and residence on the campus is required except for those living in their homes or with relatives. Scholarships in substantial amounts are available, and there are no residential restrictions on these awards. There is also a loan fund. A limited number of opportunities for self-help enable some students to earn part of their expenses. Fraternities do not provide living accommodations. There are no sororities. *For statistics see* COLLEGES AND UNIVERSITIES. J. R. To.

**SWASTIKA,** an even cross, the arms of which are bent at a right angle. Since all four bars point in the same direction (either clockwise, or counter-clockwise) the form creates an impression of perpetual rotation.

The origin of the swastika is unknown. For thousands of years, it has been used as a symbol of the sun, of infinity, of continuing re-creation, as well as a decorative motive, in the Americas, China, Egypt, Greece, Scandinavia, and elsewhere. It has been found in the catacombs of Rome, on textiles of the Inca period, and on relics which were unearthed on the site of Troy. It is one of the sacred signs of Buddhism.

The connection with Buddhism probably made the swastika fashionable among some intellectually exclusive European groups at the turn of this century. For example, the books of the "Stefan George Circle" showed a swastika on their covers. At the same time, the sign began to be used by some groups of extremist Teutonic nationalists in Austria because of the mistaken belief that the swastika was of Indian origin and, therefore, following their race doctrine, an "Aryan" motif symbolic of their self-designated racial superiority.

According to one of Hitler's biographers, Konrad Heiden, some irregular German Free Corps who later formed the nucleus of the early Nazis, brought the swastika from Finland and Estonia where it was an official emblem, to Germany. In 1920, many troops wore the swastika on their helmets when they occupied Berlin in their abortive attempt to overthrow the German Republic. In his autobiography, *Mein Kampf,* Hitler claims, to have "laid down, after countless attempts, the final form" of the official Nazi flag: a black swastika in a white circle on red ground—red standing for socialism, white for nationalism—and the swastika, in Hitler's words, symbolizing "the fight for victory of Aryan man and of the idea of creative work, which in itself eternally has been anti-semitic and eternally will be anti-semitic." As Heiden said, the Nazi swastika emblem had "the effect of an iron octopus, a monster, aggressively reaching out in all directions—hence its menacing and frightening effect. In 1921, (it) . . . was unfurled in the open for the first time. The effect was so inflammatory that Hitler himself was surprised and pleased. In the swastika historical accident gave Hitler one of his mightiest magic weapons."

From March 1933, a few weeks after Hitler's ascent to power, the swastika flag had to be hoisted in Germany side by side with the national colors; from September 1935 until the downfall of the regime in 1945, it was the official flag of the Third Reich. The emblem was prominently displayed not only on all German military uniforms, airplanes, tanks, etc. but also on all public buildings, on German postal stamps, etc. In view of the strong identification of the swastika with National Socialism, after World War II Allied occupation authorities ordered its eradication from public view. J. H. E. F.

**SWATOW** [swɑ′tau′], a port on the estuary of the Han River, in Kwangtung Province, China, 170 mi. northeast of Hong Kong and 600 mi. southwest of Shanghai. Swatow is the outlet for Chaoan (Chaochow), 27 mi. to the north. The port was opened to foreign trade in 1858 by the Treaty of Tientsin with Great Britain, but the contact of Swatow with the Western world began about two centuries earlier. The first Westerners settled on Namao Island, just offshore from Swatow, trading in opium and kidnapping Chinese emigrants, who were destined for southeast Asia for sale in slave markets elsewhere. Many of the Chinese residents in southeast Asia and America came from Swatow. Swatow is noted for its grass cloth, fans, linen embroidery, and laces. Fishing is an important occupation. Refining of sugar constitutes the chief industry in the city, and the export of refined sugar amounts to 5,000,000 tons a year. The Swatow harbor measures 2.24 sq. mi., with depths of water ranging from 19.7 ft. to 65.6 ft. Averaging 71.6° F., the temperature at Swatow rises to 100.4° F. in summer and falls to 39.2° F. in winter. Typhoons occasionally hit the port. Annual precipitation ranges from 49 to 55 in. Pop. 1947, 180,000. J. E. F.

**SWAZILAND** [swɑ′ziland], a small British protectorate on the northeast border of the Union of South Africa, bounded on the east by Mozambique and Natal, and on the south, west, and north by the Transvaal. Swaziland, roughly oval in shape, has an area of 6,705 sq. mi. The western part of the region is traversed by high ridges and the general elevation there is about 4,000 ft. above sea level. In the eastern section of the protectorate the malaria-ridden lowlands lie about 500 ft. above sea level. Swaziland is covered by wide stretches of bushes and grassland. There are no forests. The whole area is drained by several rivers which flow into the Delagoa Bay region.

In 1953 the population totaled 207,000. At the 1946 census there were approximately 3,200 Europeans and a small group of mixed descent numbering 740. The largest native group, the Swazis, are a branch of the great Bantu race and are related to the Zulus. Mbabane, the capital of Swaziland, is situated in the west central section of the protectorate. The government is in the hands of a resident British commissioner assisted by an advisory council of nine members. He is responsible to the high commissioner for Basutoland, the Bechuanaland protectorate, and Swaziland, who is in turn responsible to the British secretary of state for commonwealth affairs. The small government revenue is

derived largely from an income tax, native tax, and customs and excise taxes.

Swaziland is not prosperous; much of the land is poor. Besides the chief crops of maize, cotton, and tobacco, there are small amounts of gold and tin. Asbestos is by far the major mineral produced, since lack of transportation prevents exploitation of rich anthracite deposits. The most important industry is cattle raising; nearly 500,000 cattle are pastured on the grasslands every year. In the grazing season, about 250,000 sheep are driven out of the Union of South Africa to the cooler climate of the high veld of western Swaziland. All transportation is by oxen or by truck and automobile. The general standard of living is low. There are several mission schools administered by various religious groups. The government also has an adequate number of primary schools, particularly important in native education.

In 1843, the Swazis won their freedom from the Zulus. The Swazis, unlike their native neighbors, became friendly with the Boers and with the British after the British occupied the Transvaal in 1877. Three years after the British withdrew from the Transvaal, the London Convention (1884) recognized the independence of Swaziland. Later, however, the Boers tried unsuccessfully to annex Swaziland. So great was the Boer pressure that the Swazis appealed to the British for help in 1886. During the gold rush of 1887 the Boer settlements in Swaziland increased considerably. In 1890 a dual British-Boer control over the area was finally established. This arrangement was unsuccessful, and in 1894 the administration of Swaziland was almost entirely taken over by the Transvaal. President S. J. P. Kruger of the Transvaal was anxious to press forward to the east coast, and hoped to obtain at Kosi Bay a seaport under Transvaal control.

When the Boer War ended in 1902 Swaziland fell into an anarchy that ended only with British annexation of the territory. Since 1906 Swaziland has been a British protectorate. About half the land is possessed by Europeans. The remainder is divided into native reserves. Despite frequent pressure from the Union of South Africa, particularly during the premierships of James B. M. Hertzog (1924-1939) and Daniel Malan (1948-1954), Swaziland has steadily refused to enter the Union, and the British authorities have taken no steps to end the separate existence of Swaziland as a protectorate.

G. S.

**SWEAT GLANDS.** *See* Mammal; Man, Functional Anatomy of (*The Tissues; The Cutaneous System*).

**SWEDEN,** a constitutional monarchy of northern Europe, occupying the eastern and larger portion of the Scandinavian Peninsula. It embraces an area of 173,394 sq. mi. or about 58 per cent of the peninsula and 4.7 per cent of all Europe; in area it is the fifth-largest European country. Sweden is somewhat smaller than France and nearly 50 per cent larger than the British Isles. It extends from 55° 20′ to 69° 4′ N. lat. and from 10° 58′ to 24° 11′ E. long. The difference in time between the Greenwich Observatory, near London, and the Stockholm Observatory is 1 hr., 12 min., and 14 sec. From north to south Sweden is nearly 1,000 mi. in length, and from east to west its greatest breadth is slightly more than 300 mi. Its boundaries have been estimated to aggregate almost 7,000 mi., of which slightly more than 4,700 mi. are coast and the remaining 2,300 mi. form the boundaries between Sweden and Norway on the west and Sweden and Finland on the northeast. For the greater part of its length the boundary between Sweden and Norway runs continuously along the ridge of the Kjölen Mountains (The Keel), which form the chief divide of the peninsula. The boundary with Finland is formed by the main channel of the rivers Köngämä, Muonio, and Torneå (Tornio).

## GEOGRAPHICAL FEATURES

**Geologic Movements.** Geologically, Sweden is a land of very ancient origin. By far the largest part of its surface is underlain by crystalline rocks formed in the earliest periods of the world's history. It is part of a very ancient massif, sometimes called Fenno-Scandia because the rocks of Finland and the Scandinavian Peninsula formed one of the most ancient continuous land masses or continents of which remnants are still preserved, like the Laurentian Shield of northeastern North America. Except for Skåne, the southernmost section of Sweden, which was partially submerged by the sea several times in the Mesozoic period of the world's geologic history, the main mass of the land of Sweden has persisted as part of one of the world's oldest continents, at least since early Silurian time. About 78 per cent of Sweden's area is underlain by Archean rocks; a little over 9 per cent is Algonkian; 12 per cent is Silurian, of which about half is metamorphic; and about 1 per cent is Mesozoic. The Archean rocks include granites, gneisses, porphyries, schists, phyllites, quartzites, leptites, and greenstones.

**Minerals.** *Iron.* Most of the valuable ore deposits are associated with porphyries and leptites. By far the largest and most important of such ore deposits are the iron ores of Lapland, in northern Sweden near the Finnish border, and those of Bergslagen, in central Sweden. In the Bergslagen district, which embraces western and northern parts of the province of Västmanland and adjacent parts of eastern Värmland and southern Kopparberg, a region long known as Dalarna, numerous deposits are worked. The Grängesberg field in southern Dalarna is considered most productive and most important of all the Bergslagen deposits. Several other iron deposits have yielded heavily in other parts of central Sweden: Dannemora and others in northern Uppland, Kantrop in Södermanland, and several in Östergötland. In the deposits of central Sweden the ore is found as layered masses,

*One of the oldest and most productive copper mines in the world is this one located near Falun, now an iron mine and foundry center.*

EWING GALLOWAY

in most cases intercalated in leptite rocks. Many of central Sweden's ore bodies have been worked almost continuously for centuries. Lapland deposits of much more recent discovery are remarkable for their great size and volume of potential ore. The largest of the deposits is at Kirunavara, veritably a mountain of magnetite in which the main ore body is more than 3 mi. in length and almost 500 ft. in thickness, enclosed between beds of porphyry. Other notable iron ore deposits in the northern or Lapland district are Gällivare, Luossavara, Tuollavara, and Svappavara. The ore throughout the district is preponderantly magnetite, mixed generally with apatite in lenticular masses; some such as Gällivare is included in leptites and gneisses. A third district of smaller size and quite different mineralogical character is that which includes the greater part of the large mountain, Taberg, situated in the province of Småland about 6 mi. south of Jönköping, where the ore is a low-grade mixture of titaniferous magnetite and olivine, a ferrous facies of a greenstone (hyperite) intrusion.

*Copper.* Copper is widely distributed throughout the mineralized section of central Sweden, but the only deposit now actively mined is near Falun, in the famous Bergslagen district, where a bed of chalcopyrite, one of the largest of that mineral in the world, has been mined for seven centuries. Other copper deposits which at one time or another have been important are at Garpenberg, in southern Dalarna; Tunaberg, in Södermanland; Bersbo, in Östergötland; and Areskutan in Jamtland.

*Other minerals.* Argentiferous or silver-bearing galena, of relatively little importance at present, has been mined at Nya Kopparberg, Guldsmedshyttan, and Kallmora, in Västmanland province, and at a few other places in the Bergslagen district. An important zinc blende, or sphalerite, deposit is worked in the Arumeberg zinc mines near Askersund; zinc ore is also mined at Ryllshyttan, Saxberget, and Stollberget, in Dalarna, and in the mines of Dannemora, in North Uppland. The rich silver mine, Sala, in the Bergslagen district, formerly so renowned for its high productivity, is almost exhausted. Manganese ore or pyrolusite has been mined in small quantities at Bölet, north of Karlsborg, and at Spexeryd and Hohult, south of Jönköping. Swedish granites are famous throughout the world for construction and for monuments; feldspar and quartz are derived from pegmatites prevalent in Archean rocks; and greenstone of distinctive character and quality is widely used and exported.

*Coal.* Sweden lacks coal except for three small districts in Skåne, aggregating about 300 sq. mi., and bearing moderately workable seams of coal from a foot to a little over a yard in thickness. The largest and northernmost of the three districts lies between Höganäs, Billesholm, and Landskrona; the central district is near Eslov railway junction and Stabbarp; and the southernmost district forms a narrow belt from Vombjön to the neighborhood of Ystad. Only the lowermost two seams are of quality and depth to warrant mining. Coal has been mined only from the northernmost district, where a low-grade variety has been brought to the surface in varying amounts, depending on the availability of foreign coal. Fire clay and shales for bricks, pipes, tiles, and other clay products are generally mined with the coal. Mines at Höganäs, Billesholm, Bjuv, Skromberga, Hyllinge, Ormantorp, and Gunnarstorp, and elsewhere in the northern district, have been most productive. The total coal production fills only a small part of Sweden's needs.

**Topography.** The whole of Scandinavia was covered with ice in the glacial epoch to a very great depth. At the time of its greatest extent, the ice sheet also covered Denmark, Finland, northern Germany, parts of Holland and Great Britain, and a large part of northwestern Russia; the North and the Baltic seas were solid fields of glacial ice. During the period of glaciation great areas of the ice-covered terrain were scoured and grooved. Huge deposits of rock materials, called till, were distributed irregularly in varying depths over practically all the land when the ice melted, and other deposits of silt, sand, gravel, and rocks were washed from the melting ice and assorted to form plains, terraces, and great serpentine ridges or eskers, called *Asar* by the Swedes, which are a widespread, distinctive feature in many parts of the country. The drainage pattern of the country was completely changed by the erosion and deposition that accompanied the glaciation, as well as by the sinking of large portions of the Scandinavian Peninsula under the weight of the ice and its subsequent rising when the ice melted away. The soils derived from the marine deposits when the land was submerged are the most productive and easily tilled in Sweden.

Sweden is separated from Norway by the great chain of the Kjölen Mountains, which form the backbone of the Scandinavian Peninsula. The eastern slope of this great massif drains almost entirely southeastward to the Baltic or, in its southern portion, southward to the Kattegat. The country may be separated into two major and distinctive natural regions, north and south, which have different features and arrangement of terrain, density of population, and cultural development. Northern Sweden, which also may be called the highland district of upper Sweden, includes the whole of Norrland, Dalarna, Värmland, and the northern part of Dalsland; southern Sweden includes all the rest of the country. Southern Sweden may be separated into three distinct subregions: the lowlands of central Sweden; the Småland highlands; and the plains of Skåne. Northern Sweden may be divided into three belts: the mountain and lake belt, the moraine and peat moss belt, and the marine and clay belt.

*Northern Sweden.* The mountain and lake belt of northern Sweden is a high, rocky slope toward Kjölen, transversed by wide, deep valleys in many of which long, narrow lakes have formed at elevations that vary by less than 300 ft. Their greatest depth is at their northwestern end. The divides between the numerous valleys form a moorland on which grow lichens, mosses, and a few flowering plants. The birch, *Betula odorata,* grows farthest up the slopes, succeeded in turn by Norway spruce, *Picea excelsa,* and a sparse growth of Scots pine. In valleys which were submerged in glacial lakes that have been drained since the ice melted back, large areas of fine fertile sand or loam were deposited and have made possible grazing and even considerable tillage at elevations from 2,000 to 2,500 ft. The moraine and peat moss belt, the middle belt of northern Sweden, lies at an elevation of from 600 to 1,500 ft. above sea level. The belt is a relatively level area cut by river valleys into plains many miles in extent, intersected by numerous stony moraines, and characterized by extensive development of marshes and peat bogs which occupy from 15 to 30 per cent of the belt. It is the moraine and peat moss belt that supports the greater part of the timber for which Sweden is famous. The forest, chiefly of Scots pine and Norway spruce, extends for more than 600 mi. along the belt, with a width that varies from 100 to more than 150 mi., a monotonous landscape broken by a few productive farms on southward-facing slopes. The farms are most numerous toward the southern part of the belt, which has a milder climate. It is in this belt that the chief ore deposits and mining enterprises of Sweden are found. The marine sand and clay belt, the easternmost belt of northern Sweden, is a region of broad coastal plains formed when the sea level

# SWEDEN

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Karasjok
Inari
Ivalo
Utsjoki
Torneträsk
Abisko
Kiruna
Jukkasjärvi
Muonio
Kittilä
Sodankylä
Rovaniemi
Kemijärvi
Kuolayarvi
Apatity
Kirovsk
Monchegorsk
Kandalaksha
Lovozero
Umba
Kem
Belomorsk
Kalgalaksha
Kestenga
Pongoma
Kochkoma
Rugozero
Yushozero
Kuyto Ozero
Vygozero
Unezhma
Onega
Arkhangelsk
Molotovsk
Nizhmozero
Yarnema
Povenets
Medvezhegorsk
Segozero
Vodlozero
Pudozh
Petrozavodsk
Sortavala
Värtsilä
Suojarvi
Kondopoga
Joensuu
Kuopio
Lieksa
Nurmes
Iisalmi
Kajaani
Oulujärvi
Kiantajärvi
Hyrynsalmi
Kuusamo
Taivalkoski
Puolanka
Raahe
Kokkola
Jakobstad
Vaasa
Seinäjoki
Kaskinen
Kristinestad
Kaskinen
Kauhajoki
Haapamäki
Virrat
Äänekoski
Keitele
Pieksämäki
Varkaus
Iisalmi
Orivesi
Tampere
Vammala
Pori
Rauma
Turku
Åbo
Helsinki
Hanko
Ekenäs
Lahti
Kotka
Hamina
Vyborg
Primorsk
Kronshtadt
Lomonosov
Petrokrepost
Dubrovka
Sinyavino
Mga
Shapki
Tosno
Ushaki
Vyritsa
Pavlovsk
Pushkin
Krasnoye Selo
Oranienbaum
Petergof
Lesnoy
Vsevolozhskiy
Irinovka
Pargolovo
Gorskaya
Zelenogorsk
Volo-yarvi
Osel'ki
Mor'ye
Chernoye
Kobona
Vystav
Naziya
Putilovo
Shapki
Ushaki
Tosno
Gatchina
Taytsy
Kolpino
Ul'yanovka
Ostrodnoye
Uritsk
Petergof
Oranienbaum
Sestroretsk
Gulf of Finland
Gorskaya
Lesnoy
Vsevolozhskiy
Irinovka
Pargolovo

SWEDEN
NORWAY
DENMARK
FINLAND
ESTONIA
LATVIA
LITHUANIA
GERMANY
POLAND
SOVIET UNION
U.S.S.R.
North Sea
Baltic Sea
Gulf of Bothnia
Gulf of Finland
Gulf of Riga
Oslo
Stockholm
Göteborg
Malmö
Copenhagen (København)
Helsinki
Leningrad
Tallinn
Riga
Kaliningrad (Königsberg)
Gdańsk (Danzig)
Hamburg
Bremen
Berlin
Kiel
Lübeck
Rostock
Warnemünde
Stettin (Szczecin)
Poznań
Bydgoszcz
Torun
Gdynia
Sopot
Elbląg
Malbork
Frankfurt
Magdeburg
Hannover
Braunschweig
Bielefeld
Dortmund
Aarhus
Odense
Esbjerg
Aalborg
Helsingborg
Karlskrona
Kalmar
Visby
Gotland
Öland
Bornholm
Saaremaa
Hiiumaa
Uppsala
Västerås
Örebro
Eskilstuna
Norrköping
Linköping
Jönköping
Karlstad
Gävle
Sundsvall
Umeå
Luleå
Kiruna
Narvik
Trondheim
Bergen
Stavanger
Kristiansand
Oslo
Drammen
Hamar
Lillehammer
Tampere
Turku
Oulu
Rovaniemi
Vaasa
Pori
Lahti
Kotka
Vyborg
Petrozavodsk
Murmansk
Arkhangelsk
Novgorod
Pskov
Tartu
Pärnu
Riga
Liepāja
Klaipėda (Memel)
Kurisches Haff
Vistula
Oder
Elbe
Rhine
Weser
Ems
Danube
Vienna
Prague
Warsaw
Gdańsk
Szczecin
Rügen
Fehmarn
Skagerrak
Kattegat
Sound
Great Belt
Little Belt
Jutland
Zealand
Fyn
Lolland
Falster
Gotland
Saaremaa
Hiiumaa
Åland Islands
Frisian Islands
North Frisian Islands
Lake Vänern
Lake Mälaren
Lake Hjälmaren
Lake Vättern
Lake Peipus
Lake Ilmen
Lake Ladoga
Lake Onega
Gulf of Bothnia
Gulf of Finland
Gulf of Riga
Kurisches Haff
Gulf of Danzig
Gulf of Gdańsk
Gulf of Bothnia
Gulf of Finland
Gulf of Riga
Gulf of Bothnia
Gulf of Finland
Gulf of Riga
Gulf of Bothnia
Gulf of Finland
Gulf of Riga

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Skonnarbo . . . . . u33
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Tumba, 1,085 . . . . . t35
Uddevalla, 26,238 . . . . . H 4
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Umeå, 17,594 . . . . . F 9
Uppsala, 65,841 . . H 7, t35
Vagnhärad, 507 . . . . . u35
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Vänersborg, 16,606 . . . . . H 5
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Vetlanda, 7,953 . . . . . I 6
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Vimmerby, 5,321 . . . . . I 6
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Ystad, 13,175 . . . . . J 5

### COUNTIES

**Not shown on map. Index key denotes approximate location.**

Älvsborg . . . . . H 5
Area . . . . . 7,919 sq. m.
Pop . . . . . 363,363

Blekinge . . . . . I 6
Area . . . . . 1,173 sq. m.
Pop . . . . . 146,303

Gavleborg . . . . . G 7
Area . . . . . 7,610 sq. m.
Pop . . . . . 289,249

Goteborg och Bohus . . . I 4
Area . . . . . 1,989 sq. m.
Pop . . . . . 568,053

Gotland . . . . . I 8
Area . . . . . 1,225 sq. m.
Pop . . . . . 58,508

Halland . . . . . I 5
Area . . . . . 1,901 sq. m.
Pop . . . . . 164,819

Jämtland . . . . . F 6
Area . . . . . 19,967 sq. m.
Pop . . . . . 145,032

Jönköping . . . . . I 6
Area . . . . . 4,447 sq. m.
Pop . . . . . 275,390

Kalmar . . . . . I 7
Area . . . . . 4,485 sq. m.
Pop . . . . . 237,978

Kopparberg . . . . . G 6
Area . . . . . 11,649 sq. m.
Pop . . . . . 272,625

Kristianstad . . . . . I 6
Area . . . . . 2,485 sq. m.
Pop . . . . . 259,433

Kronoberg . . . . . I 6
Area . . . . . 3,828 sq. m.
Pop . . . . . 158,971

Malmöhus . . . . . J 5
Area . . . . . 1,872 sq. m.
Pop . . . . . 589,591

Norrbotten . . . . . E10
Area . . . . . 40,754 sq. m.
Pop . . . . . 246,534

Örebro . . . . . H 6
Area . . . . . 3,560 sq. m.
Pop . . . . . 250,962

Östergötland . . . . . H 6
Area . . . . . 4,266 sq. m.
Pop . . . . . 351,967

Skaraborg . . . . . H 5
Area . . . . . 3,629 sq. m.
Pop . . . . . 249,064

Södermanland . . . . . H 7
Area . . . . . 2,634 sq. m.
Pop . . . . . 217,197

Stockholm . . . . . H 8
Area . . . . . 3,041 sq. m.
Pop . . . . . 1,133,385

Uppsala . . . . . H 7
Area . . . . . 2,056 sq. m.
Pop . . . . . 156,835

Varmland . . . . . H 5
Area . . . . . 7,427 sq. m.
Pop . . . . . 285,186

Vasterbotten . . . . . F 9
Area . . . . . 22,839 sq. m.
Pop . . . . . 232,655

Vasternorrland . . . . . F 8
Area . . . . . 9,925 sq. m.
Pop . . . . . 287,301

Västmanland . . . . . H 7
Area . . . . . 2,611 sq. m.
Pop . . . . . 210,205

## FINLAND

**Area . . . . . 130,159 sq. m.**
**Population . . . . 4,065,027**

### CITIES AND TOWNS

Äanekoski, 5,948 . . . . . F11
Borgå, 8,446 . . . . . G11
Ekenas, 4,601 . . . . . G10
Haapamäki, 1,792 . . . . . F11
Hameenlinna, 22,911 . . . . . G11
Hamina, 7,184 . . . . . G12
Hango, 6,751 . . . . . H10
Heinola, 8,806 . . . . . G12
Helsinki, 376,554 . . . . . G11
Hyrynsalmi, 4,719 . . . . . E13
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Jyväskylä, 30,831 . . . . . F11
Kajaani, 11,208 . . . . . E12
Karvia . . . . . F10
Kaskö, 1,663 . . . . . F 9
Kauhajoki . . . . . F10
Kauhava . . . . . F10
Kauliranta . . . . . D10
Kemi, 23,203 . . . . . E11
Kemijarvi, 2,871 . . . . . D12
Kittila, 1,266 . . . . . D11
Kokkola, 13,499 . . . . . F10
Kontiomaki . . . . . E13
Kotka, 24,024 . . . . . G12
Kouvola, 10,824 . . . . . G12
Kristinestad, 2,829 . . . . . F 9
Kuopio, 33,813 . . . . . F12
Kuusamo . . . . . E13
Lahti, 44,755 . . . . . G11
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Mikkeli, 16,359 . . . . . G12
Muonio . . . . . D10
Naantali, 1,988 . . . . . G10
Nurmes, 1,437 . . . . . F13
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Pieksamo, 8,041 . . . . . F12
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Raahe, 4,508 . . . . . E11
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Rautalampi, 958 . . . . . F12
Riihimaki, 16,868 . . . . . G11
Rovaniemi, 13,485 . . . . . D11
Salo, 9,398 . . . . . G10
Savonlinna, 11,649 . . . G13
Seinäjoki, 7,493 . . . . . F10
Sodankyla, 1,641 . . . . . D12
Taivalkoski . . . . . E13
Tampere, 101,509 . . . . . G10
Tornio, 3,359 . . . . . E11
Turku, 102,804 . . . . . G10
Utajarvi . . . . . E12
Utsjoki . . . . . C12
Uusikaupunki, 4,276 . . G 9
Vaasa, 35,157 . . . . . F 9
Valkeakoski, 12,321 . . . G11
Varkaus, 18,061 . . . . . F12
Vilppula, 1,563 . . . . . F11
Virrat, 1,387 . . . . . F10

### COUNTIES

**Not shown on map. Index key denotes approximate location.**

Ahvenanmaa (Åland) . G 8
Area . . . . . 572 sq. m.
Pop . . . . . 21,350

Home . . . . . G11
Area . . . . . 7,118 sq. m.
Pop . . . . . 559,251

Kuopio . . . . . F12
Area . . . . . 13,806 sq. m.
Pop . . . . . 472,937

Kymi . . . . . G12
Area . . . . . 3,537 sq. m.
Pop . . . . . 313,179

Lappi . . . . . D11
Area . . . . . 36,308 sq. m.
Pop . . . . . 169,211

Mikkeli . . . . . G12
Area . . . . . 6,750 sq. m.
Pop . . . . . 243,266

Oulu . . . . . E11
Area . . . . . 21,887 sq. m.
Pop . . . . . 363,808

Turku-Pori . . . . . G10
Area . . . . . 8,500 sq. m.
Pop . . . . . 635,077

Uusimaa . . . . . G11
Area . . . . . 4,400 sq. m.
Pop . . . . . 680,043

Vaasa . . . . . F 9
Area . . . . . 15,062 sq. m.
Pop . . . . . 606,905

## NORWAY

**Area . . . . . 125,193 sq. m.**
**Population . . . . 3,310,821**

### CITIES AND TOWNS

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### COUNTIES

**Not shown on map. Index key denotes approximate location.**

Akershus . . . . . H 4
Area . . . . . 2,070 sq. m.
Pop . . . . . 624,200

Aust-Agder . . . . . H 3
Area . . . . . 3,607 sq. m.
Pop . . . . . 76,060

Buskerud . . . . . H 4
Area . . . . . 5,738 sq. m.
Pop . . . . . 157,650

Finnmark . . . . . B13
Area . . . . . 18,581 sq. m.
Pop . . . . . 65,411

Hedmark . . . . . G 4
Area . . . . . 10,620 sq. m.
Pop . . . . . 173,619

Hordaland . . . . . G 1
Area . . . . . 6,060 sq. m.
Pop . . . . . 314,017

Möre og Romsdal . . . . . F 2
Area . . . . . 5,812 sq. m.
Pop . . . . . 194,409

Nordland . . . . . D 6
Area . . . . . 14,728 sq. m.
Pop . . . . . 223,356

Nord-Tronaelag . . . . . E 4
Area . . . . . 8,700 sq. m.
Pop . . . . . 111,892

Oppland . . . . . G 4
Area . . . . . 9,600 sq. m.
Pop . . . . . 161,678

Östfold . . . . . H 4
Area . . . . . 1,613 sq. m.
Pop . . . . . 187,496

Rogaland . . . . . H 1
Area . . . . . 3,500 sq. m.
Pop . . . . . 214,219

Sogn og Fjordane . . . . . G 1
Area . . . . . 7,100 sq. m.
Pop . . . . . 97,998

Sör-Tröndelag . . . . . F 4
Area . . . . . 7,240 sq. m.
Pop . . . . . 198,863

Telemark . . . . . H 3
Area . . . . . 5,800 sq. m.
Pop . . . . . 137,698

Troms . . . . . C 8
Area . . . . . 10,000 sq. m.
Poo . . . . . 118,584

Vest-Agder . . . . . H 2
Area . . . . . 2,800 sq. m.
Pop . . . . . 97,711

Vestfold . . . . . H 4
Area . . . . . 903 sq. m.
Pop . . . . . 156,960

## ICELAND

**Area . . . . . 39,709 sq. m.**
**Population . . . . . 148,938**

### CITIES AND TOWNS

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Blonduós, 469 . . . . . n22
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Höfn, 435 . . . . . n25
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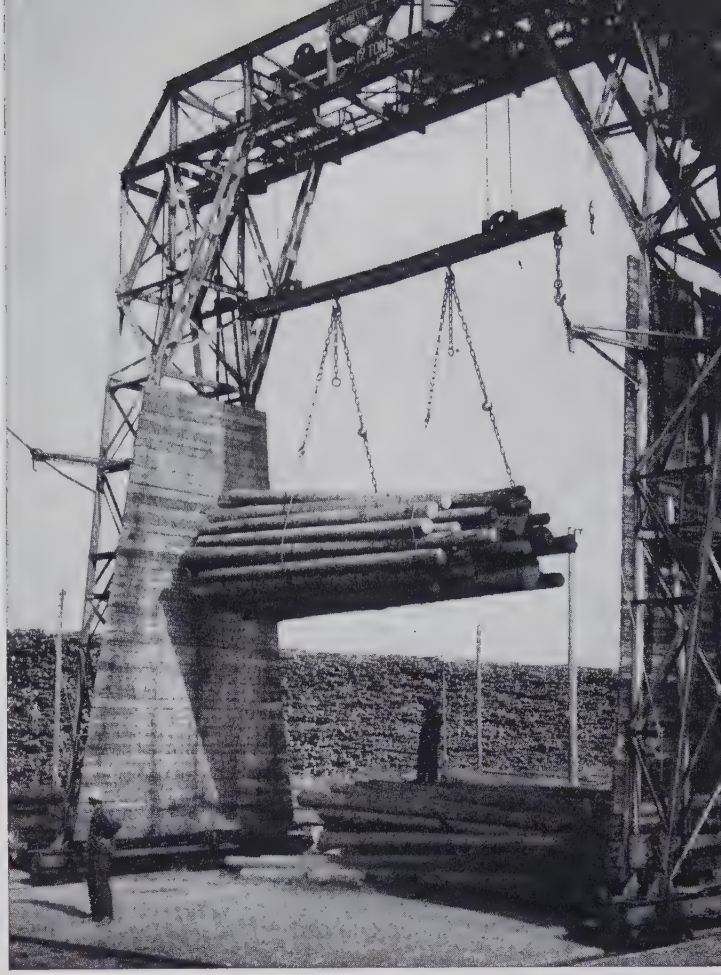
Odai . . . . . o22
Olafsfjördur, 937 . . . . . m23
Olafsvik, 516 . . . . . n21
Raufarhöfn, 384 . . . . . m25
Reykjavik, 58,761 . . . . . n22
Seydisfjördur, 768 . . . . n26
Siglufjördur, 2,921 . . . . . m23
Vik, 316 . . . . . o23
Vopnafjördur, 324 . . . . n25

stood from 450 to 600 ft. higher than now. The marine deposits penetrate from 50 to 100 mi. into the interior. As the land rose after the ice melted, the many rivers that flow across the belt cut deep gorges into the deposits to form canyons and chasms which constitute some of the most scenic features of Sweden's picturesque terrain. The whole region of northern Sweden is sparsely populated. Forestry is the chief industry and yields the larger part of the income, although mining, particularly of iron ore, forms an important feature of the economy. Farming plays a minor role. The great water-power potentialities of the region are rapidly being developed. The serious problem of transportation gradually is being solved.

*Southern Sweden.* The three subregions of southern Sweden—the central lowlands, the Småland highlands, and the plains of Skåne—are the areas of densest population. Here also is the greatest concentration of manufacturing and farming; forestry and mining likewise play appreciable roles in the economy of the region. The central lowlands are marked by great level areas of marine deposits. They are generally arable and fertile, with soils which are readily adapted to mechanized farming. The lowlands are interior extensions of the marine sand and clay belt of northern Sweden, and in turn are connected with similar coastal districts in the Småland highlands and the plains of Skåne. The forests are luxuriant throughout the area, but much of the land is devoted to farming and grazing. The Småland highlands include all the area of southern Sweden that lies above the extent of marine deposits. It so closely resembles the moraine and peat moss belt of northern Sweden in terrain and vegetation that it may properly be considered an outlier of that continental plateau. Though the rivers are not so large and deep, the countryside is largely mantled with a coarse, sandy, and gravelly till, little adapted to farming but favorable to growth of pine and spruce. There are great areas of peat bogs; only the more temperate climate makes the Småland highlands suitable for habitation. The Skåne plains, southernmost and most gracious of all the Swedish regions and provinces, constitute the chief agricultural section of the country. The soils, derived from marine deposits interspersed with glacial till, are highly fertile, easily tilled, and productive of high yields of many crops. The plains are subdivided into a number of minor areas by rocky ridges, remnants of primitive rock that intersect the province chiefly from northwest to southeast. Forests of maple, beech, oak, ash, and other hardwoods once grew luxuriantly over the plain, but most have been cleared to make way for highly profitable agricultural activities.

**Climate.** The climate of Sweden is milder, sunnier, and drier than that of most countries in northwestern Europe, particularly in winter. This is because of the beneficent effect of the Gulf Drift, which washes the western coast of the Scandinavian Peninsula, and the warming and drying of the air that is borne by the prevailing westerly winds up the windward side of the Kjölen in Norway and then poured down from the heights upon the lower regions of Sweden. The great latitudinal extent of Sweden makes its northern region considerably colder, shortens its growing season, increases disparity between length of day and night, and otherwise increases differences in climatic elements from north to south.

Although 15 per cent of Sweden lies north of the Arctic Circle and all of it is north of the fifty-fifth parallel, the south-southwesterly winds that prevail over northwestern Europe, especially during the winter, give Sweden a climate that promotes forest growth, makes agriculture more productive than in similar latitudes elsewhere, and enables the



BURTON HOLMES FROM EWING GALLOWAY

*Hoisting timber at a lumber yard near Ostersund, a machinery and furniture manufacturing center*

people to live comfortably. Summers are short and winters are long in all of Sweden; in summer the days are long, the nights short, and in winter the reverse holds true. In June the average daily sunshine for the country is 50 per cent; in December only 26 per cent; thus the heating effect of the sun in summer is unimpaired, while in winter radiation is considerably reduced by the widespread cloud cover. Summers are consequently warmer than they would otherwise be, and winters milder. At Lund, in southern Sweden, winter is 72 days long; spring, 72 days; summer, 142 days; and autumn, 79 days. At Karesuando, in northern Lappland, winter is 215 days long; spring, 43 days; summer, 57 days; and autumn, 50 days.

Generally speaking, the climate of Sweden lies about midway between continental and marine types, the northern part of the country being more continental and the southern part more marine. At Lund the mean monthly temperature varies from 33.5° F. in January to 61.5° F. in July, a range of 28 degrees, and the mean annual temperature is 45° F. At Karesuando the mean monthly temperature varies from 5.7° F. in January to 53.5° F. in July, a range of 47.8 degrees, and the mean annual temperature is near 27° F. Snow falls everywhere in Sweden every year, but the snow cover remains on the ground in open country only 47 days in Skåne, while it lasts 170 to 190 days in Karesuando. In the severe winter of 1880-1881 snow covered the ground in Stockholm for 166 days, but in the mild winter of 1881-1882 it remained only 33 days. Ice cover on the lakes averages about 115 days in southern Sweden, 150 days in central Sweden, and 200 days or more in northern Sweden. The Gulf of Bothnia is generally covered with ice every year. Ice begins to form along

shore about the middle of November and begins to break up in the latter part of May. Fogs are fairly common in the Gulf of Bothnia and the northern Baltic.

The average annual rainfall varies from 18 in. on the island of Gotland in the Baltic and the northernmost sections, to 28 in. on the western coast of southern Sweden. The average for the whole of Sweden is about 21 in.; but 18 to 20 in. for the northern provinces, 22 in. for central Sweden, and a little over 23 in. for southern Sweden, is remarkable uniformity for so large an area with so diversified a terrain. The maximum precipitation comes in late summer, with a secondary maximum in October for some places, which in exceptional cases may be the primary maximum. The minimum comes in February, March, or April. Summer and autumn rainfall distinguish all of Sweden, and drought conditions prevail from the latter part of winter to the early part of autumn, which frequently is a hazard for agriculture. Storms are relatively frequent on the west coast, averaging twenty a year, while on the east coast they vary from two to eight along the Gulf of Bothnia.

**Soils.** The soils of Sweden are chiefly forest and peat soils, most of them with varying degrees of acidity except where calcareous parent materials may affect them. Podsols, with light gray leached upper horizon, and gray to brown forest soils partly podsolized, are the dominant classes in Sweden. Only in the central lowland and on the plains of Skåne are the soils well suited for crop growing.

**Rivers and Lakes.** The many rivers of Sweden, none very large, form a close lattice pattern obvious on even a large map of the country and play an important role in its economy. More than 45 rivers drain basins of 600 sq. mi. or more. They may be divided into two major groups: those which include the great mountain lakes and valleys, from Dalälven northward to Tornälven and across Norrland from Kjölen to the Gulf of Bothnia, and those which form part of the great lake-river systems of Mälaren, Norrström, Vättern, Motalaström, Vänern, and Gotaälven. The principal rivers of Sweden are important as sources of power, for transport of timber, and for recreation, but because they are so swift and turbulent in most of their courses, they cannot be extensively used for boating. The largest lakes of Sweden are those of the Swedish lowland: Vänern, 2,141 sq. mi. in extent; Vättern, 733 sq. mi.; Mälaren, 440 sq. mi.; and Hjälmaren, 185 sq. mi. They are all navigable and much used for transportation. The numerous mountain lakes are so-called finger-lakes, long and narrow. They are used considerably for timber transport, but little for navigation or other purposes. They lie at nearly the same elevation, the difference being less than 300 ft. between the lowest and highest. A lake of exceptional beauty and popular regard is Siljan in Dalarna, the historical and political heart of Sweden.

**Canals.** The famous canal of Sweden is the Göta, which connects Stockholm with Göteborg on the southwestern coast; Jönköping, at the southern end of Vättern; and numerous other cities of the central lowland. Both Vänern and Vättern, the two largest lakes of Sweden, form part of the Göta Canal system. Other major canals of Sweden are the Hjälmaren; the Strömsholm; the Trollhätte, which bypasses all the falls on the lower Götaälven; and the Södertälje, one of the oldest still in use.

**Forests.** The forests of Sweden are its largest and most assured source of income. Nearly all of northern Sweden, most of the Småland highlands, large parts of the central lowland, and even rugged ridges about the plains of Skåne are forested. Conifers—spruce, fir, and pine—form the major part of the forest, but in southern Sweden hardwoods are now sparingly mixed among the conifers, where once they grew over large areas. More than 37 per cent of the forest lands belong to the nation, 2 per cent to towns or other political divisions, and the rest to private individuals.

**Flora.** The flora may be classified into five major regions: (1) the Alpine, which comprises the northernmost and highest part of the country, and consists chiefly of alpine heath, all dwarfed or small species; (2) the birch forest, next below the bare Alpine zone, characterized by the Alpine birch, *Betula odorata,* a subalpine tree forming low, thin forests of highly irregular extent and including in places quaking aspen, *Populus tremula,* and rowan, *Sorbus aucuparia*; (3) the northern region of coniferous forest, composed chiefly of Scots pine, *Pinus sylvestris,* and common spruce, *Picea excelsa,* which occupy the greater part of Sweden's land surface and determine the general character of the landscape; (4) the southern region of coniferous forest, which has been largely felled to make way for farm land but, where it persists, is strongly mixed with trees of oak flora—oak, ash, elm, linden, maple, and others; and (5) the beech forest region, now largely in cultivation after clearing of the forest, but where stands still exist is well mixed with oak, alder, and other deciduous trees, and in places with Scots pine. A luxuriant lake vegetation characterizes the many bodies of water; along the coast a rich halophytic or salt-tolerant flora thrives, and bogs and moors support a goodly stand of acid-tolerant plants. The vegetation of Sweden remains fresh and green throughout the growing period.

**Fauna.** Sweden has a richly diversified fauna both because of its length from north to south and its varied terrain. Each of the great vegetation regions supports its own distinctive species of insects, birds, rodents, fish, and carnivores. Its largest mammals are elk, red deer, reindeer, bear, lynx, and wolf; smaller mammals include the lemming, wolverine, pine marten, weasel, badger, hedgehog, squirrel, shrew, and bat. The birds are particularly numerous and varied. There are relatively few reptiles, frogs, or toads. The lakes, rivers, and coastal waters are abundantly supplied with fish and some shellfish. A distinctive fish of the Baltic and the Gulf of Bothnia is the strömming, *Clupea harengus,* a species of herring. In inland waters the native crayfish is abundant and considered a delicacy. W. E. E.

## ETHNOLOGY AND POPULATION

**Population.** The total population of Sweden in the 1950 census was 7,046,920; in 1945 there were 10,193 Lapps. In 1950 there were over 100,000 foreigners in residence. According to the 1950 census figures, the largest city in Sweden was Stockholm, the capital, with 745,936. Only two other cities exceeded 100,000; these were Göteborg, with 353,991, and Malmö, with 192,498. More than 50 per cent of the population was rural.

**Religion.** Most Swedes belong to the Lutheran Church, which receives state support. Other leading religious groups are: Baptists, 56,898; Methodists, 11,450; Roman Catholics, 4,763 (with a vicar apostolic at Stockholm); and Jews, 6,653. Some civil disabilities are attached to members of non-Lutheran churches.

**Economic Pursuits.** In 1945, 60.4 per cent (2,509,635) of the people were dependent upon industry for a livelihood. Agriculture absorbed 1,867,190 persons, and the professions the remainder.

**Language.** The official language is Swedish and the formal dialect is that of Stockholm, but several variants are used in the kingdom. Finnish is spoken in the northern provinces.

EWING GALLOWAY

*VIEW OF STOCKHOLM SHOWING PART OF THE CITY'S TRAFFIC ARTERY SYSTEM*

## GOVERNMENT AND POLITICS

**Central Government.** Sweden is a constitutional monarchy with Gustavus VI (1882- ) as king. The king appoints some officers and is commander in chief of the armed forces. The cabinet exercises the other executive functions. The legislative branch is the *Riksdag,* which is composed of 150 members in the First Chamber, or upper house, and 230 members in the Second Chamber, or lower house. The members of the First Chamber are elected by provincial legislatures, or *Landstings,* and town councilors; persons over the age of 35, eligible to vote in municipal elections, may be elected. The members of the Second Chamber are elected by universal suffrage, and persons over the age of 25 are eligible for membership. The kingdom is divided into four high district courts, 186 district courts, 71 city, and 115 country superior courts. The king appoints a chancellor (Justitie-Kansler), who is administrative head of the legal system. An attorney general (Justitie-Ombudsman) is elected by the Riksdag. Trial by jury is only for cases involving liberty of the press; other cases are tried by judges.

**Civil Rights.** All persons, male and female, over the age of 23 have the right of suffrage, and only those barred by law because of criminal or religious reasons are prevented from voting. Complete freedom of speech, press, and assemblage is guaranteed by the constitution, and right of appeal to the courts is permitted for redress of any infringement.

**Political Parties.** The strength of the political parties in the Second Chamber in 1952 was: 108 Social Democrats, 59 Liberals (People's Party), 28 from the Farmers' (Peasants') Party, 30 Conservatives, and 5 Communists. The First Chamber had 81 Social Democrats, 23 Conservatives, 23 from the Farmer's Party, 20 from the Liberal, and 3 Communists. The majority party, the Social Democratic, has been in power since 1932, except for a brief interruption in 1936, and its political philosophy is Marxist. Per Albin Hansson, who died on Oct. 6, 1946, was its leader for many years. The Conservatives represent the large landowners and industrialists. The Farmer's Party is composed of small landowners, consistently conservative and desiring protection of home agriculture from foreign competition. The Liberal or People's Party is midway between the Social Democrats and Conservatives in political ideology. No great political conflict has arisen in the past decade; the coalition cabinet of World War II functioned well in spite of differences of opinion on domestic issues.

**Public Finance.** The estimated budget for 1951-1952 was (approximate figures in American dollars based on exchange value of the krona): receipts 6,406,395,000 kr. ($1,281,279,000); expenditures, 5,751,026,000 kr. ($1,150,205,000).

In 1950 the public debt was 12,421,000,000 kr. ($2,484,200,000). The unit of currency is the Swedish krona of 100 öre and is valued on the exchange at 19.4 cents and officially at 5.14 kroner to the dollar. The Sveriges Riksbank is the official state bank of Sweden; its directors are elected by the Riksdag for three-year terms and its president is appointed by the king.

**Government Enterprises.** The Swedish government owns most of the railroads, telegraph and telephone lines, extensive forest lands (more than 10,000,000 acres), the tobacco monopoly and control of liquor, and the Swedish

EWING GALLOWAY

*Molten steel being poured into ingot molds at one of the foundries in Fagersta, the center of Sweden's pig iron industry*

Broadcasting Company. Subsidies are granted to farmers and to co-operatives, to the Swedish Inter-Continental Air Lines, to A/B Aerotransport Company, and to a private mining corporation, the Kiruna-Luossavara Bolaget (KLB), which is state owned. The Royal Board of Waterfalls controls over 40 per cent of the production of hydroelectric power and plans for the production of more.

**Armed Forces.** The armed forces of Sweden were on a war footing throughout World War II. All males between 20 and 47 are subject to military service. In 1950 there were 19 infantry, 3 cavalry, 4 tank, and 9 artillery units; 3 antiaircraft regiments and 4 antiaircraft defense corps; and 18 air force squadrons. The navy had 4 cruisers, 6 coastal defense ships, 21 destroyers, 6 torpedo boats, 42 mine sweepers, 28 submarines, and 2 mine layers; 2 cruisers and 2 destroyers were being built. Sweden is divided into six naval districts, with stations at Karlskrona, Stockholm, and Göteborg. Naval personnel totaled approximately 10,000 officers and men. The Royal Coast Artillery maintains defense forts at Vaxholm (Stockholm), Karlskrona, Alvsborg, Gotland, and Hemsö.

*An electrical equipment manufacturing plant at Västerås*

EWING GALLOWAY

## ECONOMIC RESOURCES AND ACTIVITIES

**Agriculture.** Agricultural production is insufficient for domestic needs, and rationing was introduced during World War II. In 1948 there were 9,215,662 acres under cultivation; 55,219,389 acres were in forest land. Hay, of which 4,297,968 metric tons were produced in 1948, is the leading crop, followed by potatoes (2,276,511 metric tons), fodder (2,080,249), and sugar beets (1,808,200); other crops, raised in lesser quantities, were oats, wheat, mixed grains, rye, and corn. In 1948 the livestock census showed 14,166,000 poultry, 2,622,000 cattle, 1,194,000 pigs, 497,000 horses, and 349,000 sheep.

**Mining.** Mining, for which Sweden is mainly noted, is concentrated in the north and is concerned chiefly with production of iron ore. In 1950, 13,611,000 metric tons of ore were produced, followed by pyrites (406,809 metric tons), coal (309,296), gold (72,300), zinc (62,094), copper (61,264), silver-lead (29,973), and manganese (11,847). The quarries provide paving blocks, cement materials, and building stone. The value of all mineral production in 1949 was $344,977,000.

**Manufacturing.** The industries of Sweden are geographically decentralized with mining and its byproducts in the north; sawmills and wood products along the Gulf of Bothnia; machinery, ball bearings, electrical machinery, telephone supplies, and motors in central Sweden, and the porcelain and glass factories of Orrefors, Kosta, and Gustafsberg in the south. The manufacture of iron and steel products far outweighs in value any other Swedish manufactures. Of the total production value of $3,205,985,000 in 1946, $1,043,925,000 was for iron and steel. Next in value were foodstuffs and spirits ($719,337,000) and paper products ($362,418,000).

**Fisheries.** The fisheries, located chiefly at Göteborg, are not extensive; in 1947 the total tonnage of fish exports was 17,591, with a value of $3,530,000. Most of the fishing is done in the North Sea, but some catches are made in the Baltic Sea.

**Commerce.** The commerce of Sweden is mainly with Great Britain, the United States, and the Soviet Union; before World War II Sweden's main customer was Germany. Imports and exports in 1950 and their values were as follows: imports, $1,220,533,000; exports, $1,141,956,000.

**Banking.** The banking system is entirely under the control of the state, and the Riksbank is the only official bank. However, there are 25 commercial banks with deposits of $1,559,000,000 and loans of $1,274,000,000. The Post Office Savings Bank also offers service to 3,591,993 depositors, who have $303,100,000 on deposit. There is very little foreign banking service in Sweden, but state bonds are held abroad in considerable quantities.

**Transportation and Communications.** Through the merchant service, composed of 2,195 ships and 2,088,579 gross tons in 1949, connections are maintained with all foreign countries. The Swedish-American Line, Svea Line, Johnson Line, Swedish Lloyd, Swedish Orient, Transatlantic,

and Transpacific provide regular steamship service between Sweden and virtually all parts of the world. Within Sweden there are 55,500 mi. of roads and 10,340 mi. of railroads; telegraph lines total 7,681 mi. and telephone wires 1,317,052 mi. The Göta Canal connects the Gulf of Bothnia with Göteborg. The Swedish Inter-Continental Air Line and Scandinavian Airlines System connects Stockholm and other Scandinavian cities with the United States; the A/B Aerotransport Company has regular flights to European capitals.

**Labor Movements and Conditions.** The labor movement, begun in the late nineteenth century and fostered by the Social Democratic Party, has had great political weight. Hjalmar Branting, long the leader of the Social Democrats, was one of the early founders of the trade union movement. The Swedish Trade Union Federation and T.C.U. have together over a million and a half members, representing over 30 per cent of the entire population over fifteen years of age. During 1950 there were 23 strikes or lockouts affecting 2,436 workers, of which all but three disputes were settled by compromise. Laws providing accident insurance, hospitalization, old-age pensions, unemployment insurance, and factory regulation offer the Swedish worker a standard of living of which he is proud, and industrialists aspire to maintain that standard.

## SOCIAL AND CULTURAL ACTIVITIES

**Standard of Living.** *Health.* The Swedish people are as healthy as the people of any state in Europe. Social medicine provides adequate safeguards against incidence of disease, and state hospitals and clinics furnish medical attention free of charge. State institutions provide treatment for tuberculosis and other respiratory diseases.

*Housing, Fuel, and Clothing.* Wartime conditions meant little construction of homes, and housing is inadequate, but co-operative and state-aided housing units are being expanded. Refugees from other countries, totaling 193,000 in 1945, complicated the housing problem. The problem of fuel has always distressed the Swedish urban housewife, but never quite so seriously as during the war. Coal imports supply almost 70 per cent of fuel demands, and the war shortage was filled by peat, firewood, briquettes, and low-grade coal. There was no motor fuel for civilian automobiles unless they ran on producer gas (wood gas); and shale oil was for military purposes only. Hot water was rationed in most of the hotels and apartment houses, and restrictions were not withdrawn until February 1947. Raw materials for clothing have always been imported, and World War II forced the manufacture of various substitutes. Shoes were made of wood and paper; fabrics of rayon and cellulose. The government subsidized new industries to produce cotton and woolen materials.

*Family Life.* The Swedish family has not changed with the years; an increasing birth rate indicates that higher costs of living have had little effect on it. The divorce rate of 8.43 per cent is not high. Since Sweden's industrialization and urbanization have not been excessively rapid, the contour of the family has not been altered appreciably. The government has built housing units and gardening plots and has given every encouragement to larger families.

*Holidays and Recreation.* Every holiday is a gala occasion, and Christmas is traditionally a great festive celebration with visits to friends and relatives. Swedes are famous for their culinary art. They are also conscious of the need for physical fitness; since the days of Pehr Henrik Ling, Sweden has been an outstanding center of physical education. The Gymnastics Association acts as a central statistical, propaganda, and co-ordinating agency. Skiing is a national sport, and a walking association encourages hiking. Cycling became popular during the war, when it was no longer possible to use an automobile. A steady improvement of the health of the Swedish people has been noted.

**Education.** The education of the Swedish people has always been extensive; school attendance between the ages of 7 and 14 is compulsory. Illiteracy is less than 1 per cent. The elementary schools had 506,505 pupils in 1947; the secondary schools, 68,453, and the people's high schools, 7,346. Eleven elementary and two higher technical schools offer professional training. Several institutions are for the blind, deaf, and mute, and other special classes. In Stockholm facilities for higher education include a semipublic university which co-operates with eight independent professional schools in the city. The universities at Uppsala (1477) and at Lund (1666) are both internationally recognized for their superior training. A fourth university is among the educational institutions at Göteborg. Agricultural institutes are located at Uppsala and at Akarp.

**Art.** Sweden's art has never been famous, except that which is functional, but its National Museum is known for its treasures. The National Association for Promotion of Fine Arts, the Swedish Arts Association, and the College of Arts in the Royal Academy have inspired the Swedish people to a sense of beauty. Swedish art is practical and real. Swedish glass from Orrefors in Småland has been famous for two decades; intricate weaving by peasant women has beautified homes and clothing; Swedish furniture has gained a high repute. A few modern artists have revealed the innate sense of beauty of the Swedes: Carl Larsson's glimpses of Swedish life; Prince Eugen's more elegant fashions; and Anders Zorn's Dalarna scenes.

**Drama, Music, and Literature.** The Swedish theatre also reveals the artistic impulses of the Swedish people. Both the Royal Dramatic Theatre, with Karl Ragnar Gierow, Per Lagerkvist, and Rune Lindström as its most famous playwrights, and the Swedish film industry are internationally known. In music, performance is preferable to composition. The Swedes have never produced a famed composer, but the Royal Opera and Academy of Music provide stimulus for enterprising artists. All peasant festivals are accompanied by singing and dancing; choral groups, singing clubs, and folk music are characteristic of Sweden. The modern literature of Sweden is not extensively known, although many countries are familiar with the writings of Selma Lagerlöf and Verner von Heidenstam. Eyvind Johnson and Vilhelm Moberg are among the foremost contemporary authors.

## HISTORY

The origins of Scandinavian man are not definitely known, but it is supposed that human life existed on the Scandinavian Peninsula as early as 12,000 B.C. Artifacts indicate a relatively high degree of civilization during the Paleolithic and Neolithic periods, and the Bronze Age showed signs of intercommunication with other European countries. The Roman Empire had trade relations with Scandinavia, but it was not until the eighth century that Scandinavia figured importantly in the history of Europe.

**Viking Period.** The Viking expeditions in which Swedes participated were mainly in the eastern Baltic. It was a Danish jarl or chieftain, Rurik, who about A.D. 862 established himself in the Russian city of Novgorod with the aid of Swedes who also participated in the attacks on Constantinople. From Novgorod, Rurik and his descendants

pushed southward and established themselves in Kiyev. Gradually these Swedish settlers mixed with the population and disappeared. Other Swedish colonists settled in the eastern Baltic littoral and opened trade with Russia, substituting the less adventurous role of merchant for that of a Viking. Within Sweden the Viking period brought a more energetic development of law, government, and society. In the ninth century Anschar (Ansgar) brought Christianity, and in 1008 Olaf Shötkonung accepted it and established a new bishopric at Skara. Missionaries followed and Sweden became Christian, although paganism remained for some time. Political unity was hard won; prominent families led the movement, with Birger of Bjälbo (Folkung dynasty) the outstanding political leader. Under his dominance Sweden resisted economic subordination to the German merchants and extended its influence in the eastern Baltic. A period of decline followed, broken only by the reign of Magnus Ericsson (1319-1356, 1359-1362), which was filled with his conflicts with Waldemar IV Atterdag of Denmark and Albert of Mecklenburg. Albert ousted Magnus and later made himself king. The feeble efforts of their leaders to maintain liberty forced the Swedes to agree to a marriage alliance with Denmark; the marriage of Haakon VI to Danish Princess Margaret in 1363 led to the union of Sweden, Norway, and Denmark in 1397.

**Union of Kalmar.** At the Diet of Kalmar in 1397, some years after the death of Haakon, Margaret persuaded the Estates to accept as king her grand-nephew, Eric of Pomerania, and the Union of Kalmar began. Sweden proved an unwilling partner in it, for revolts and friction constantly forced Danish intervention. Margaret and Eric were both distrustful of the Swedish nobility, and Danes received the chief offices. The traditional home of Swedish liberties, Dalarna, under Engelbrekt Engelbrektsson, was the first to rebel against Danish overlordship. Although Engelbrekt's leadership lasted only from 1434 to 1436, he created a sense of national unity; Karl Knutsson, who had been associated with Engelbrekt, assumed direction and in 1448 was elected king of Sweden as Charles VIII. One abortive attempt by Christian I to re-establish Danish control in Sweden failed, but in 1520 Christian II succeeded. The unfortunate celebration in 1521 of the execution of the leaders of the Swedish rebellion was fatal to the union. Upon receipt of the news, Gustavus Ericsson aroused his countrymen against the Danes. A simultaneous revolt in Denmark against Christian II assisted Gustavus in his fight, and at Strängnäs in June 1523 he was crowned king of Sweden as Gustavus I Vasa.

**Vasa Period.** The immediate problems facing Gustavus were formidable. Recognition by other states was slow; Denmark opposed the new regime; the country was devastated and divided because Gustavus' chief support had come from the peasants and not the nobility. Loans from Lübeck had given that city a strangle hold upon the economic life of Sweden which Gustavus wanted to end. Several revolts were successfully met by 1530, and trade and domestic peace soon provided both cash and unity. A religious revolt against Catholicism, begun by Olaus and Laurentius Petri in 1525, gave Gustavus an opportunity to seize church lands, and the Swedes had an independent church. The successors of Gustavus were not of his mettle. His son Eric, who ruled from 1560 to 1568, was insane, and Eric's brother John led a revolt which deposed him. An unstable and unscrupulous spendthrift, John mismanaged the kingdom and proposed a return to Catholicism. His death in 1592 brought his son, Sigismund of Poland, to the throne, and he, as an ardent Catholic, drove the Swedes to rebellion. In 1604 Charles IX, the third son of Gustavus Vasa, was elected king of Sweden. Though he lived but a short time, Charles restored financial stability, increased Sweden's possessions abroad, and built a strong monarchy for his son, Gustavus II.

*GRIPSHOLM PALACE NOT FAR FROM STOCKHOLM. FOUNDED IN THE FOURTEENTH CENTURY, THIS PALACE FIGURED LARGELY IN THE HISTORY OF THE VASA KINGS OF SWEDEN.*

EWING GALLOWAY

*Gustavus Adolphus.* The reign of Gustavus II, known as Gustavus Adolphus, was filled with incessant wars. It was fortunate for Sweden that in 1612 he appointed one of Sweden's greatest statesmen, Count Axel Oxenstierna, as chancellor. The chancellor ruled Sweden, managed the finances, and handled diplomacy while Gustavus pursued his military ambitions. Wars with Denmark and Russia were successfully concluded. A war with Poland from 1621 to 1629, was ended to permit Gustavus' intervention in the Thirty Years' War in Germany. In the same decade reforms took place at home, among them the departmental organization of government, the foundation of trading companies,

the proposals for colonial settlements in America, and the development of Swedish mines. The military fame of Gustavus in Germany rested on his superior tactics and the national character of his army, as opposed to the polygot nature of the Imperial forces. The victories at Leipzig (1631) and Lützen (1632) made Sweden a world power for a time. The death of Gustavus at Lützen did not materially affect the outcome of the war. Count Oxenstierna carried the burden of government and was chief minister for Sweden's young queen, Christina, from 1644 to 1654. The victories won by Swedish forces in Pomerania and at Leipzig saved the Swedish empire in Germany, and Lennart Torstensson, Gustavus' chief commander, forced Denmark to terms in 1644-1645. The treaties of Westphalia in 1648 and Copenhagen in 1660 marked the zenith of Swedish power in Europe.

*GUSTAVUS ADOLPHUS PRAYING BEFORE THE BATTLE OF LÜTZEN, WHICH HE FOUGHT SUCCESSFULLY AGAINST ALBRECHT VON WALLENSTEIN, BUT IN WHICH HE WAS MORTALLY WOUNDED*

CULVER SERVICE

*Queen Christina.* The reforms begun in the reign of Gustavus were continued by Oxenstierna; Swedish colonies were solidly founded; Sweden's wealth was increased and communications were improved. The reign of Christina, also an era of cultural renaissance, was terminated by the Queen's decision to adopt Catholicism. Unable to reign in Lutheran Sweden as a convert to the Church of Rome, Christina in 1654 announced her abdication, and on June 6 of that year gave up her throne in favor of her cousin. Her public entrance into the Church was made at Innsbruck in 1655.

**Sweden's Struggle for an Empire.** *Charles X Gustavus.* With the abdication of Christina the direct descendants of Gustavus Vasa ceased to rule. Charles X Gustavus, nephew of Gustavus Adolphus, began the *reduktions* whereby the crown regained thousands of acres of land and millions of dollars worth of property. The administration of Eric Oxenstierna, son of the famous chancellor, was devoted to economic reconstruction, necessary after the lavish expenditures of Christina and the heavy expenses of the Thirty Years' War. Sweden gained Livonia through an undeclared and unwarranted attack on Poland in 1656, although Charles extricated himself only through Denmark's mistake of declaring war on Sweden. The king withdrew his troops from Poland and crossed Germany into southern Jutland. An attack on the Danes ordinarily required a navy, but an unprecedented cold winter froze the waters between the islands and offered a chance to cross to Sjælland. Danish surprise at the daring of the Swedes was reflected in their unpreparedness, and Charles forced the Danish army to surrender. The ensuing Treaty of Roskilde in 1658 was the most notable victory that Sweden had won over Denmark. Now for the first time Sweden was free to undertake trade with western Europe through its "door to the west" at Göteborg.

*Charles XI.* The regency which ruled Sweden during the minority of Charles XI frittered away both the advantages and money which had been won. Swedish participation in Louis XIV's Dutch War of 1672-1679 was nearly disastrous. A Danish invasion of the southern provinces and Frederick William's invasion of Pomerania would have cost Sweden heavily if it had not been for the intervention of Louis XIV. The country was economically exhausted, and it was necessary for Charles XI to continue his father's policy of the *reduktions.* In the Riksdag of 1680 these were approved, but more importantly the members voted absolute powers to the king. The army was rebuilt on the grand scale of Gustavus Adolphus.

*Charles XII.* The reign of Charles XII, who became king in 1697 at the age of 15, marked the end of Sweden as an important European power. Denmark, together with Prussia, Poland, and Russia, plotted against Swedish domination of the Baltic, and in 1700 the attack was launched. Charles countered with an immediate attack on Denmark, and in August 1700 he forced it to sign the Treaty of Travendal. He then moved eastward to relieve Narva, which was besieged by the Russian army. There in November Charles

won his first victory over Russia, and from 1702 to 1707 he fought in Livonia and Poland against the Polish king, Augustus II. The latter was forced to sign the Convention of Altranstädt in September 1707, recognizing Stanislas Leszczyáski as king of Poland.

In 1707 Charles invaded Russia, although his officers had advised strongly against such a daring venture. The invasion progressed nicely until the scorched earth tactics of

*CHARLES XII, VARIOUSLY CALLED "THE ALEXANDER OF THE NORTH" AND "MADMAN OF THE NORTH"*

FROM AN ENCRAVING BY P. TARJÉ

CULVER SERVICE

Peter the Great forced Charles to turn south to winter. Orders were given to General Adam Levenhaupt to bring reinforcements, and negotiations with Mazepa, commander of the Cossacks, were begun. Both arrived in Charles's camp without their promised supplies or men. When Peter learned of the plight of the Swedes, he turned to fight them, and at the Battle of Poltava, June 28, 1709, the whole Swedish army of nearly 18,000 men was captured. Charles fled to Turkey and spent five fruitless years in exile trying to persuade the Turks to attack Russia. In 1714 he was almost forcibly ejected from Turkish territory and returned to Stralsund, which he defended against the newly formed northern alliance of 1714-1716. Shortly before the city's fall in December 1715, Charles left and returned to Sweden. By 1715 Peter the Great had taken the Baltic provinces, had nearly completed St. Petersburg, and had several times invaded Finland. Prussia was in control of the Oder River and most of Swedish Pomerania. Denmark had sold Bremen and Werden to George I of England. In 1716 Charles faced an invasion of Sweden by Denmark and Russia, which did not materialize, and himself invaded Norway, where he was killed at Fredrikstad, Nov. 30, 1718, while directing the siege. His death ended Sweden's fight for an empire; only Finland and western Pomerania remained of the once extensive Swedish possessions.

**Eighteenth Century.** *Cultural Progress.* The Riksdag dominated Swedish affairs during the reigns of Ulrika Eleonora, Frederick I, and Adolphus Frederick. The enlightenment of the eighteenth century brought a great renaissance which produced the Academy of Sciences, the Academy of Letters, the Swedish Linguistic Society, the Academy of Arts, the Royal Swedish Opera, and the Royal Academy of Music. Olof von Dalin, as a poet and historian; Sven Lagerbring, as a critical historian; Karl Mikael Bellmann and Johan Henrik Kellgren as poets and critics; and Eric Benzelius, as the famed librarian at the University of Uppsala, were representative of this cultural progress. Scientific progress was reflected in the work of Carl von Linné (Linnaeus) in botany, T. O. Bergman and Karl Wilhelm Scheele in chemistry, Anders Celsius in astronomy, and Emanuel Swedenborg in geology, medicine, and religion.

*Gustavus III.* Gustavus III, who ruled from 1771 to 1792, is and is regarded as Sweden's enlightened despot, resolved to restore the powers of the monarchy. The revolution of 1772, managed by the king himself, substituted the monarchy for the Riksdag as the authority in Sweden. In the latter part of his reign Gustavus embarked on an ill-advised project to regain Sweden's possessions. The war with Russia in 1788-1790 might have proved disastrous for the Swedes after Denmark invaded their territory, but the French Revolution, the partition of Poland, and Swedish victories in Finland caused Russia to sign a peace, and Sweden escaped unscathed. The anticlimax was the assassination of Gustavus by Johan Jakob Anckarström, one of his nobles, on Mar. 29, 1792.

*Gustavus IV Adolphus.* During the eight years of regency which followed, Sweden drifted. Gustavus IV Adolphus, crowned king in 1800, was a reactionary who proposed intervention in France. Because of his foolhardy policy, Sweden lost Pomerania in the German war of 1806-1807 and faced Russia alone in 1808 in Finland. Gustavus, by now demented, was deposed by a *coup d'état* in March 1809, and on Sept. 17, 1809, peace was made with Russia, Sweden losing Finland.

*Bernadotte.* Charles XIII, who had been regent from 1792 to 1800, ruled from 1809 to 1818. Since he was childless, it was necessary for the Riksdag to select an heir apparent. A French marshal, Bernadotte, was chosen as heir to Charles. In order to win Norway he reoriented Swedish foreign policy from France toward Russia and joined the coalition of

*JEAN BAPTISTE JULES BERNADOTTE, WHO BECAME KING OF SWEDEN AS CHARLES XIV JOHN*

FROM AN ENGRAVING BY T. JOHNSON

CULVER SERVICE

1813-1814 against Napoleon. Denmark ceded Norway to Sweden at Kiel, Jan. 14, 1814, and Bernadotte forced the Norwegians to recognize the act. The Eidsvold Constitution, framed by the Norwegians in 1814, was retained as the basic law, and Norway was permitted its own parliament.

**Nineteenth Century.** *Era of Peace.* The end of the Napoleonic era brought a peace to Scandinavia which lasted until 1940. Bernadotte, who in 1818 succeeded Charles XIII as king and took the name Charles XIV John, was opposed to liberal movements and personally felt responsible for the preservation of the union. Toward the latter part of his life his increasing conservatism and irritating habits lost him

## RULERS OF SWEDEN

| Dates of Reign | | Name | Succession | Born | Died |
|---|---|---|---|---|---|
| 980 | 995 | Eric the Victorious | King at Uppsala | c. 964 | 995 |
| 995 | 1022 | Olaf Shötkonung | Son of Eric; first king of all Sweden | ? | 1022 |
| 1022 | c. 1050 | Amund (Anund) | Son of Olaf | ? | c. 1050 |
| c. 1050 | 1060 | Emund the Aged | Half brother of Amund | ? | 1060 |
| | | | **STENKIL'S DYNASTY** | | |
| c. 1060 | 1066 | Stenkil Ragnvaldsson | Son-in-law of Emund; elected king | ? | 1066 |
| 1066 | 1078 | Haco (Haakon) the Red | Period of civil war | ? | ? |
| c. 1079 | 1099 | Halstan } joint | Sons of Stenkil; divided kingdom with brother-in-law Blotsweyn; Inge I sole ruler from 1099. | ? | c. 1099 |
| | 1112 | Inge I the Elder } rule | | ? | 1112 |
| c. 1112 | 1118 | Philip } joint | Sons of Inge I; Inge II sole ruler from 1118 | ? | 1118 |
| | 1122 | Inge II the Younger } rule | | ? | 1122 |
| ? | ? | Kol | | ? | ? |
| | | | **SVERKER'S AND ERIC'S DYNASTIES (ALTERNATING KINGSHIP)** | | |
| 1130 | 1150 | Sverker I the Elder | Grandson of Blotsweyn; son of Kol; deposed | ? | 1156 |
| 1150 | 1160 | Eric IX (St. Eric) | Elected; "Saint" a popular appellation; killed at Uppsala by Danes | ? | 1160 |
| 1161 | 1167 | Charles VII Sverkersson | Son of Sverker; killed by Cnut Ericsson | ? | 1167 |
| 1167 | 1196 | Cnut Ericsson | Son of Eric IX | ? | 1196 |
| 1196 | c. 1208 | Sverker II Charlesson | Son of Charles VII | ? | c. 1210 |
| 1208 | 1216 | Eric X Cnutsson | Son of Cnut | ? | 1216 |
| 1216 | 1222 | John I Sverkersson | Son of Sverker II; last of Sverker dynasty | ? | 1229 |
| 1222 | 1229 | Eric XI Ericsson | Son of Eric X; king's council governed | ? | 1250 |
| 1229 | 1234 | Cnut II the Tall | Usurped the throne | ? | 1234 |
| 1234 | 1250 | Eric XI restored | Son of Eric X | ? | 1250 |
| | | | **THE FOLKUNG DYNASTY** | | |
| 1250 | 1266 | Birger of Bjälbo | Regent for son Waldemar; created earl, 1248 | ? | 1266 |
| 1250 | 1275 | Waldemar (Valdemar) | Son of Birger of Bjälbo; deposed | c. 1238 | c. 1302 |
| 1275 | 1290 | Magnus I (Magnus Ladulås) | Son of Birger; took crown from brother Waldemar | 1240 | 1290 |
| 1290 | 1318 | Birger II | Son of Magnus I; regency from 1290 to 1302; deposed | 1280 | 1321 |
| 1319 | 1356 | Magnus II (Magnus Eriksson or Smek) | Son of Duke Eric; king also of Norway to 1343; regency 1319 to 1332; set aside by Eric XII. | 1316 | 1374 |
| 1356 | 1359 | Eric XII Magnusson | Son of Magnus II; usurped throne from father | 1339 | 1359 |
| 1359 | 1362 | Magnus II Ericsson (Smek) restored | Son of Duke Eric; deposed | 1316 | 1374 |
| 1362 | 1363 | Haakon VI Magnusson | Son of Magnus II; also king of Norway 1343 to 1380; deposed in Sweden | 1339 | 1380 |
| 1363 | 1389 | Albert of Mecklenburg | Son of Magnus II's sister; defeated Haakon; defeated by Margaret | c. 1340 | 1412 |
| 1389 | 1412 | Margaret of Denmark | Daughter of Waldemar IV of Denmark; reigned over Denmark, Norway, and Sweden; Eric XIII nominally king from 1397 | 1353 | 1412 |
| 1412 | 1434 | Eric XIII (Eric VII of Denmark) | Grand-nephew of Margaret; deposed by Swedes | 1382 | 1459 |
| 1434 | 1436 | Engelbrekt Engelbrektsson | A noble; led peasant revolt and became regent; murdered | ? | 1436 |
| 1436 | 1440 | Charles VIII (Karl Knutsson) | Elected regent by nobles | c. 1408 | 1470 |
| 1440 | 1448 | Christopher of Bavaria | As Christopher III, king of Denmark and Norway also | 1418 | 1448 |
| 1448 | 1457 | Charles VIII | Elected king | c. 1408 | 1470 |
| 1457 | 1464 | Christian I of Oldenburg | Seized throne; king of Denmark and Norway also; dethroned | 1426 | 1481 |
| 1464 | 1465 | Charles VIII | Temporarily restored | c. 1408 | 1470 |
| 1467 | 1470 | Charles VIII | Again recalled | c. 1408 | 1470 |
| 1470 | 1497 | Sten Sture the Elder | Nephew of Charles VIII of Sweden; regent and elected protector, 1471 | c. 1440 | 1503 |
| 1497 | 1501 | John II (John I of Denmark) | Son of Christian I of Denmark; displaced Sture | 1455 | 1513 |
| 1501 | 1503 | Sten Sture | Regained power | c. 1440 | 1503 |
| 1503 | 1512 | Svante Sture | Protector and regent | 1455 | 1512 |
| 1512 | 1520 | Sten Sture the Younger | Protector-regent; killed in battle | c. 1493 | 1520 |
| 1520 | 1523 | Christian II the Cruel | Son of John II; king of Denmark and Norway, 1513 to 1523; died in prison | 1481 | 1559 |
| | | | **THE VASA DYNASTY** | | |
| 1523 | 1560 | Gustavus I (Gustavus Vasa) | Regent 1521 to 1523; then king | 1496 | 1560 |
| 1560 | 1568 | Eric XIV | Son of Gustavus I; dethroned by John III | 1533 | 1577 |
| 1568 | 1592 | John III | Second son of Gustavus I | 1537 | 1592 |
| 1592 | 1604 | Sigismund Vasa | Son of John III; Charles IX regent; king of Poland 1587 to 1632 | 1566 | 1632 |
| 1604 | 1611 | Charles IX | Son of Gustavus I; regent 1599-1604; then king | 1550 | 1611 |
| 1611 | 1632 | Gustavus II (Gustavus Adolphus) | Son of Charles IX; killed 1632 | 1594 | 1632 |
| 1632 | 1654 | Christina | Daughter of Gustavus II; regency, 1632 to 1644; abdicated | 1626 | 1689 |
| | | | **THE PALATINATE DYNASTY** | | |
| 1654 | 1660 | Charles X Gustavus | Cousin of Christina; son of John Casimir and Catherine, daughter of Charles IX | 1622 | 1660 |
| 1660 | 1697 | Charles XI | Son of Charles X; regency 1660 to 1672 | 1655 | 1697 |
| 1697 | 1718 | Charles XII | Son of Charles XI, killed in battle | 1682 | 1718 |
| 1718 | 1720 | Ulrika Eleonora | Daughter of Charles XI; transferred crown to husband | 1688 | 1741 |
| 1720 | 1751 | Frederick I | Prince of Hesse-Cassel; husband of Ulrika Eleanora | 1676 | 1751 |
| | | | **THE HOLSTEIN-GOTTORP DYNASTY** | | |
| 1751 | 1771 | Adolphus Frederick | Duke of Holstein-Gottorp and bishop of Lübeck; elected king of Sweden | 1710 | 1771 |
| 1771 | 1792 | Gustavus III | Son of Adolphus Frederick; assassinated | 1746 | 1792 |
| 1792 | 1809 | Gustavus IV (Gustavus Adolphus) | Son of Gustavus III; regency, 1792-1800; deposed | 1778 | 1837 |
| 1809 | 1818 | Charles XIII | Son of Adolphus Frederick; also king of Norway from 1814; had no heir | 1748 | 1818 |
| | | | **THE BERNADOTTE DYNASTY** | | |
| 1818 | 1844 | Charles XIV John | Jean Baptiste Jules Bernadotte, French general; elected king | c. 1763 | 1844 |
| 1844 | 1859 | Oscar I | Son of Charles XIV | 1799 | 1859 |
| 1859 | 1872 | Charles XV | Son of Oscar I | 1826 | 1872 |
| 1872 | 1907 | Oscar II | Son of Oscar I; Norway became separate kingdom in 1905 | 1829 | 1907 |
| 1907 | 1950 | Gustavus (Gustaf) V | Son of Oscar II | 1858 | 1950 |
| 1950 | | Gustavus VI (Gustaf Adolf) | Son of Gustavus (Gustaf) V | 1882 | |

some public sympathy. During his reign, however, Sweden improved its transportation system, accepted the Industrial Revolution, developed its natural resources, and became a leading country in the production of fine steel. Culturally, too, the early nineteenth century was a great age for Sweden. Pehr Henrik Ling made it a pioneer in physical education. Erik Gustaf Geijer and Esaias Tegnér studied its past and colorfully portrayed it for their generation. J. J. Berzelius in chemistry, Anders Retzius in anatomy, and the Caroline Medical Institute made it a pioneer in science.

*Oscar I.* Oscar I's accession in 1844, though eagerly anticipated, proved a bitter disappointment to liberals desiring political reform. It was not until 1867, during Charles XV's reign, that new constitutional laws were written to answer the demands of the middle class and peasants. Lars Johan Hierta, the editor of the *Aftonbladet,* Johan Gabriel Richert, Louis de Geer, and others led the movement for political reform; novelist Fredrika Bremer stressed the importance of women's rights. Religious liberty was conferred; local government increased in power, and a modern banking system was introduced in the Stockholms Enskilda Bank. The Bessemer process proved a great boon to steel production, and the building of the Göta Canal and railroads furnished a modern transport system.

*Oscar II.* During Oscar II's reign, 1872-1907, growing industrialization and the rise of the Social Democratic Party under Karl H. Branting brought the passage of extensive social legislation and factory regulation acts. Co-operative societies, for which Sweden is noted, were begun. August Strindberg, Gustaf af Geijerstam, Verner von Heidenstam, and Selma Lagerlöf were world-famous in literature. In the scientific field the explorers Sven Hedin and N. A. E. Nordenskjöld and the archaeologist Oskar Montelius won international praise. Gustaf von Rosen, Nils Forsberg, Julius Kronberg, and Karl Gustaf Hellquist portrayed Sweden's past greatness in oils. Impressionism in the work of Ernst Josephson and Richard Bergh influenced a modern school of art. The major problem faced by Oscar II was the dissolution of the union of Norway and Sweden. The union had not been happy for either partner, and disputes continually arose. In 1905 the Norwegian Storting, or Parliament, formally passed a dissolution act, forcing Sweden to decide whether Norway should be permitted to "depart in peace." Oscar II was a proponent of that course, and at Karlstad, Sept. 23, 1905, an agreement was signed which gave Norway its freedom.

**Twentieth Century.** Sweden's problems changed little in the new century. Gustavus V, more commonly known as King Gustaf, who came to the throne in 1907, understood the role of a democratic monarch and endeared himself and his family to the Swedish people. The Social Democratic Party steadily gained in political influence, and the strike of 1909, which was almost fatal to the trade-union movement, only temporarily checked this advance. The discussions of military preparedness in 1914 stirred party animosities and was an issue of some significance.

During World War I Sweden remained neutral and insisted on the observance of her neutral rights. Nevertheless, some 300 Swedish ships were lost, rationing was introduced, and the people felt the impact of modern war for the first time. In 1918 the country assumed a benevolent attitude toward Finland and its revolution, but the question of possession of the Ahvenanmaa (Åland) Islands, decided by the League of Nations, nearly caused war between the two states. Postwar problems were like those of the rest of Europe; inflation, national debts, and security in foreign relations occupied the government's attention. The depression of the 1930's gave the Social Democratic Party a majority in the Riksdag, where it remained dominant, with a minor interruption, until 1950. Swedish industries, in the two decades between the wars, produced more than ever before, and a monopolistic tendency developed. The Swedish co-operatives, however, met this challenge and forged ahead. The Kooperativa Förbundet (KF), founded in 1899, with its 750,000 members, was outstanding. Consumer, wholesale, and manufacturing co-operatives were organized; in 1941 the KF had a capital of $23,000,000 and a wholesale business of $64,000,000. Moreover, the Nordisk Andelsförbund had formed a Scandinavian co-operative society with members in Norway, Denmark, Sweden, and Finland.

Sweden's foreign policy from 1920 to 1939 was pacific; it joined the League of Nations, the World Court, and other international organizations. In World War II Sweden again stated its desire to remain neutral, but the German invasions of Norway and Denmark and the threats of attack on Sweden necessitated preparedness measures. Armed forces were kept on an active basis, and several thousand persons were killed on patrol duty. Sweden's sympathies, not often openly expressed, were on the side of the Allies; Norway, Denmark, and other countries were aided through the Red Cross, many of their refugees were harbored, and other forms of relief were extended to them. After the war Sweden took its place in the United Nations, thus resuming its former peacetime role of international co-operation. Its sincere interest was shown through the millions of dollars in gifts and reconstruction credits granted to Denmark, Finland, and Norway. Export-import agreements were reached with Denmark and Norway, and other trade pacts were signed with the Soviet Union, France, Great Britain, and Poland. Sweden was invited to participate in the European Recovery Program in 1948 and aided materially, through its industrial production, Europe's advance in postwar reconstruction. In 1950 the country was able, for the first time since 1938-1939, to achieve a near balance in imports and exports and thus was well on the road to economic readjustment. Increasing political pressure from the Soviet Union on western Europe caused virtual abandonment of three trade agreements; the one with Poland was supposed to provide Sweden with coal essential for the steel industry. In 1948 discussion of a Scandinavian defense pact was strongly urged upon the northern countries, but Sweden continued its policy of neutrality, holding to the view that rearmament would hasten conflict between East and West and increase Soviet pressure on Finland. The same considerations caused the Swedish government to refuse adherence to the North Atlantic Pact which was signed in 1949 by Norway and Denmark. Subsequent negotiations in 1950 among the three Scandinavian countries attempted to reach a formula which would leave Denmark and Norway within the North Atlantic Pact and yet provide a joint defense system among the three countries. Sweden participated in all the activities of the United Nations, and a member of the royal family, Count Folke Bernadotte, was assassinated while serving the United Nations in Palestine. With the death of the popular Gustavus V in 1950 at the age of ninety-two, Sweden's longest reign came to an end. Under his son and successor, Gustavus VI (Gustaf Adolf), the Swedish people, both internationally and in domestic affairs, appeared entirely content to continue pursuing the middle way.

R. E. L.

**SWEDENBORG, EMANUEL** [sve'dənbɔry] (1688-1772), Swedish scientist, philosopher, and theologian, whose

writings form the doctrinal basis of the Church of the New Jerusalem, or New Church, was born at Stockholm on Jan. 29, 1688. His father was a professor at Uppsala and Lutheran bishop of Skara. The family name was Svedberg, but when Swedenborg was ennobled in 1719 the "en" was added, corresponding to the German "von."

Swedenborg was trained at Uppsala and travelled widely in Europe. His earliest interests were scientific, and these interests led him into every branch of the physical sciences. His accomplishments in this field were considerable: his invention of a device for transporting boats overland was the immediate occasion of his elevation to the House of Nobles, where he became a leader, and his knowledge of mineralogy led to his appointment as assessor of the Royal Bureau of Mines in 1716, a position which he held for over thirty years. Swedenborg wrote many notable scientific volumes and published a periodical, *Daedalus hyperboreus,* devoted mainly to mechanics and invention. His works were collected and published by official order near the end of the nineteenth century.

In his theories of the principles of the universe and in the field of mechanics Swedenborg was far in advance of his time and anticipated many later discoveries; his nebular hypothesis antedated Kant and Laplace. He also devised a method of ascertaining longitude at sea by the stars, invented an ear trumpet for the deaf, set forth a molecular theory, began the science of crystallography, drew up plans for a machine gun, a submarine, and a flying machine, and even developed a theory of cosmic atoms.

In 1743, however, Swedenborg was turning his mind from the natural sciences to religion. At this time he began to experience a sort of illumination which, he felt, gave him an extraordinary and even a divine sense of spiritual perception. He reported that he plunged deep into mysticism, heard mysterious conversations, saw visions, received revelations, saw heaven and hell, and conversed directly with angels and even with God himself. He felt himself divinely commissioned to expound his revelations and perceptions and even suggested that his theological writings were dictated to him by God. In 1745 he published his Latin *Worship and Love of God* (English translation, 1801), and in 1749 he completed his vast Latin work in eight volumes, *Arcana coelestia* (English translation, 1783). These works were followed by a dozen other books of a theological nature, the best known being *Heaven and Hell,* first published in Latin in 1758 and in English in 1778, and *The Apocalypse Revealed* (Latin, 1766; English, 1791).

Swedenborg taught that God's divinely inspired revelation, or Word, was found in certain (but not all) books of the Bible. This Word, however, was not the commonly accepted sense of the written record, but in a more or less hidden spiritual meaning which Swedenborg felt it was his mission to reveal. There is accordingly a certain esoteric principle in his system of doctrine.

Swedenborg died on Mar. 29, 1772, while on a visit to London. He was buried in the Swedish Lutheran church there, but in 1908 the Swedish government transferred his remains with considerable honor and ceremony back to his native land and deposited them in the cathedral at Uppsala.

E. T. C.

**SWEDENBORGIANS** [swidənbɔ′rjiəns], members of the Church of the New Jerusalem, or New Church, and followers of Emanuel Swedenborg (1688-1772), Swedish scientist and theologian.

Swedenborg's doctrinal system was complicated and complete, and it contained an esoteric element. He taught a correspondence or relationship between all things in the universe, including God, angels, man, and all earthly substances, by means of "discrete degrees," different from "continuous degrees" or the ordinary degree relationship, which involves the relationship of cause and effect.

Much Swedenborg teaching follows Protestant theology, though with divergencies. Its distinguishing characteristic is its view of the Word of God, the divine revelation plenarily dictated by God and inspired in every word. According to this view, the Word is found in the Old Testament in the Pentateuch, Joshua, Judges, Samuel, Kings, Psalms, and the prophets from Isaiah to Malachi, while in the New Testament it is in the four Gospels and Revelation only; the other biblical books are important for life and devotion but are not a part of the Word.

The Word of God, however, cannot be found in the Scriptures, Swedenborg believed, if they are interpreted like other writings in their ordinary sense. In addition to their literal meaning for men there is a spiritual meaning adapted to angels, and Swedenborg's revelations or perceptions were designed to disclose or provide the key to that spiritual sense. It is at this point that the esoteric principle enters.

Swedenborgian churches grew up in London in 1784 and were incorporated in 1821. A new church society was formed at Baltimore in 1792. The General Convention of the New Jerusalem in the United States of America was organized in 1817.

There are two Swedenborgian bodies in the United States. The General Convention had 52 congregations and nearly 4,621 members in 1947. The other body, called the General Church of the New Jerusalem, was formed in 1890 by the withdrawal of the Pennsylvania Association on the issue of strict adherence to the teachings of Swedenborg as an inspired revelation. Its headquarters are at Bryn Athyn, Pa., and it reported 10 churches with approximately 1,496 members in 1950.

E. T. C.

**SWEDISH,** the language spoken by about 6,500,000 persons in Sweden and by the coastal population of Österbotten (Vaasa) and Nyland (Uusimaa) in Finland; it is also spoken on most of the islands of the Baltic, including some off the coast of Estonia. Swedish was the principal tongue of 342,916 persons in Finland in 1930, and furthermore it is spoken as a second language by all cultivated Finns. Altogether Swedish is spoken by about half of the whole Nordic group.

With Icelandic, Norwegian, and Danish, Swedish is a Scandinavian language, but Swedish and Danish form an East Scandinavian or East Norse group, characterized by, among other things, a monophthongization of the Old Norse diphthongs, *kaupa, bein,* and *heyra* having become *köpa, ben,* and *höra,* and by a tendency to unite the old masculine and feminine in a common gender. Swedish is differentiated from Danish by its retention of intervocalic *p, t,* and *k* (Sw. *slipa, eta, taka;* Dan. *slibe, de, ta*[*ge*]), by its preservations of different vowel qualities in endings, where Danish uniformly has *-e,* and by a musical word accent similar to that used in Norway. Both in forms and in pronunciation Swedish thus remains at an older stage than Danish. Like Danish and Norwegian, Swedish has been strongly influenced in vocabulary, especially by low German during the Hansa period and by French in the eighteenth century, though these influences are far less important than the French influence on English.

The Swedish standard written language is most closely related to the town dialects of central Sweden in Uppsala, Stockholm, and the towns of Södermanland. There are many and different dialects whose boundary lines in the

main cut across the country. To the south the dialects of Skåne, Halland, and Blekinge have been affected by their former subjection to Denmark. North of these follow the dialects of Gotland and then the dialects of central Sweden, bordered to the north by the dialect of Dalecarlia, beyond which the Norrland dialects stretch up to the boundaries of Norway and Finland. In the extreme north a Finno-Ugric dialect is spoken by the Lapps. Of the islands, Gotland has the most original dialect. The dialects of Finland are called East Swedish dialects. Runic inscriptions in Sweden date from the fifth century, the oldest manuscripts from about 1250. S. E.

**SWEDISH LITERATURE.** The old pagan literature in Sweden was destroyed when Christianity was introduced, but rock engravings and runic stones prove that Sweden in Viking times had a rich lyric and epic literature, equivalent to the Icelandic. In medieval literature, St. Birgitta's writings in the fourteenth century played a predominant part; but some historical chronicles are also preserved from that period, as well as poems, ballads, and folk songs. Olaus Petri, who introduced the Lutheran Reformation into Sweden in 1527, was an historian of real importance and has been called the father of Swedish prose. The abrupt severing of Catholic traditions resulted in a setback in Swedish cultural development, but in the reign of Gustavus Adolphus, at the beginning of the seventeenth century, there was an intellectual renaissance which put its stamp on Swedish literature. Lars Wivallius (1605-1669) was a widely read lyricist, and Georg Stiernhielm (1598-1672) published in 1658 the poem *Hercules,* written in hexameter on antique models. Other writers from the same century used Italian and French models in their poetry. Johan Runius (1679-1713) was perhaps the most popular poet of this period, but he stood aside from literary schools.

**Eighteenth Century.** During the eighteenth century the influence of French and English literature was strongly felt. Olof von Dalin (1708-1763) published a moral weekly, *Argus,* for which Addison's *Spectator* was used as model, and he also wrote a great epic, *Svenska friheten* ("Swedish Freedom"), which was influenced by Voltaire's *Henriade.* Of special interest in his *Saga om hästen* ("Saga of the Horse"), a political allegory. His feminine contemporary, Hedvig Charlotta Nordenflycht (1718-1763), reflected the influence of Rousseau; she was an ardent champion of French taste in literature and, in general, of the ideas of the Enlightenment. The foremost representative of the Enlightenment, however, was Johan Henrik Kellgren (1751-1795). Kellgren's early works were influenced by libertinism, but later his philosophy became more noble, showing an understanding of great humanitarian ideals. In his opposition to mysticism and superstition especially, an opposition typical of this period, he used his gift of satire with crushing effect. A new influence appeared in the work of Tomas Thorild (1759-1808), who belonged to a movement originating with Rousseau, which was represented in Germany by the writers of the *Sturm und Drang.* Thorild was a firm believer in the possibility that enlightenment might create a better world. He published a magazine in which he expressed his opinions on cultural and social problems, and once he declared: "I had only one thought in my life: to explain all nature and to reform the whole world." When he found that Sweden was too small a country for the world republic which he planned to establish, he left for England; but he soon returned to his homeland, later becoming a professor in a German university. Thorild was the great prose writer of the *Sturm und Drang* movement in Sweden. The movement's great poet was Bengt Lidner (1757-1793); but Thorild's dominant themes were strength and harmony, while Lidner regarded the miseries of life as a mystery he could never understand. Lidner's period of creation was very short, but some of his poems doubtless represent the best of the period. Among other poets of this era, Carl Gustaf af Leopold (1756-1829) and Anna Maria Lenngren (1755-1817) should be mentioned. In the 1790's the latter published several poems in a style of middle-class realism which made her one of Sweden's most popular poets. Jakob Wallenberg (1746-1778) and Karl Mikael Bellman (1740-1795) were the first humorists in Swedish literature. The former is remembered for his travelogue of a trip to China. Bellman began early as a poet and singer of his own songs. He took his models from Stockholm's lowest classes, whose life he depicted with pronounced naturalism and joyous grace.

**Romanticism.** From the earliest times the most popular tales in Sweden were the Icelandic sagas, of which printed as well as handwritten copies had spread all over the country. At the beginning of the eighteenth century several foreign short stories were translated into Swedish and accepted as folk literature. The first Swedish original novel published in the 1740's was influenced by the old sagas, even though, like the heroic novel in France, it referred to contemporary happenings. The sentimental family novels by Kotzebue and La Fontaine, which were very popular during the latter part of the eighteenth century, prepared the way for Romanticism. During the eighteenth century, the impetus in Swedish literature came primarily from France and England, but during the first decades of the nineteenth century, influences from Germany were strongly felt. The leader of the Swedish neo-Romantic school was Per Daniel Atterbom (1790-1855) who, as a student at Uppsala University, founded a literary society and edited a monthly magazine. His mythical plays, *Fågel blå* (1814) (Blue Bird), and *Lycksalighltens ö* (1824) ("Isle of Bliss") are the most typical products of the new movement. The transition from the old school to the new is represented by Johan Olof Wallin (1779-1839), the most important religious poet of Sweden. Eric Johan Stagnelius (1793-1823) is often mentioned as the most gifted poet of the neo-Romantic school. His poetry is characterized by a glowing passion and a pompous form, but it was only after his death, when his collected poems were published, that he won recognition. The first decades of the nineteenth century were the golden age of Swedish literature. In addition to writers already mentioned, Esaias Tegnér (1782-1846) and Eric Gustaf Geijer (1783-1847) produced works which are now looked upon as classics in Swedish literature. Tegnér's political pathos won him acclaim as Sweden's national poet, and his *Frithiofs saga* is often mentioned as Sweden's national epic. Carl Jonas Love Almqvist (1793-1866) was the most important novelist of the 1830's, and his large production marks the development from neo-Romanticism to a new realistic school. Fredrika Bremer (1801-1865) fought for equal rights for women and is often mentioned as the founder of this movement in Sweden. She pictured everyday life in her novels and short stories, which, together with her travelogues, were widely read. In the middle of the century—the age of post-Romanticism—there was a group of poets who identified themselves with political liberalism in Europe. In Sweden this liberalism was linked, as a rule, with Scandinavianism, a movement toward greater unity among the Scandinavian countries. The great poet of the time in the Swedish language was, however, Johan Ludvig Runeberg (1804-1877), a native of Finland. Runeberg advocated simplicity and

realism in poetry, but Romantic tendencies continued to live in the Swedish literature of both Sweden and Finland during the period of realism that he inaugurated. Zachris Topelius (1818-1898) is the most important representative of this late Romanticism. He was a lyric poet, but he also wrote charming stories for children, and his historical novels belong to the most widely read works in Swedish literature.

After the middle of the nineteenth century a new and rich era was inaugurated with Abraham Viktor Rydberg (1828-1895) and Carl Snoilsky (1814-1903). Rydberg came from the lower classes, had difficulty in obtaining an education, and wrote under the influence of the liberal ideas of his time; his poetry reflects a strong Romanticism imbued with a deep idealism that verges on mysticism. Snoilsky, even though an aristocrat by birth and in his outlook on life, tried to understand and promote the liberal ideas of his generation; impressions from southern Europe inspired him to write poems filled with a sense of beauty and the joy of life, but he is mainly remembered for his poems upon themes from Swedish history.

The public of the 1880's looked upon Rydberg and Snoilsky as the leading authors of the day, but in the history of literature it is August Strindberg (1849-1912) and other representatives of the new Naturalism who dominated the 1880's, just as Verner von Heidenstam (1859-1940), Gustaf Fröding (1860-1911), Selma Ottiliana Lovisa Lagerlöf (1858-1940), and others are identified with the new Romanticism of the 1890's. In his youth Strindberg had already emancipated himself from the spirit of philosophical idealism which then prevailed in Swedish university circles. In his drama *Mäster Olof,* first printed in 1878, he gave voice to revolutionary enthusiasm, but his study of Shakespeare seems to have been the first impetus toward the realistic style which he later developed. With *Röda rummet* (1879) *(The Red Room)* Strindberg wrote the first great social novel ever written in Swedish, and this novel made him the leader of an entire group of realistic authors. The discussion of social problems became one of his main interests. In *Giftas* (1884) *(Married)* he opposed the emancipation of women; but he also wrote novels having no social tendency—for example, *Hemsöborna* (1887) ("The People of Hemsö")—which is often mentioned as the best novel ever written on life in the Swedish countryside. The following year, he published *Fröken Julie* (variously translated as *Countess Julia, Miss Julia,* and *Julia*), constructed after Zola's theories of a naturalistic drama. At the end of the century he published two modern mystery plays, using a new technique, *Till Damaskus* (1898) ("On the Way to Damascus") and *Vid högre rätt* (1899) ("The Higher Court"). During the first years of the twentieth century, he published several plays, some of them having historical themes. His last important work was *Stora Landsvägen* (1909) ("The Great Highway"), in which he sought, in lyrical dramatic form, to find a solution for his stormy and contradictory life.

To the Naturalistic period in Swedish literature also belongs Victoria Benedictsson (1850-1888), who used the pen name Ernst Ahlgren. She published short stories illustrating life in southern Sweden and novels in which she discussed the ideas of the time. Gustaf af Geijerstam (1858-1909) was a popular author of realistic novels and plays, who kept his popularity even after the realism of the 1880's had been succeeded by the Romanticism of the 1890's. The most gifted poet of the group was Ola Hansson (1860-1925), who moved to Germany and had no real influence on the literary development in Sweden.

Oscar Levertin (1862-1906) was first influenced by Strindberg, but later became a close friend of Verner von Heidenstam (1859-1940), with whom he co-operated in introducing the new Romanticism of the 1890's. Levertin, a learned scholar having a great love for Sweden's cultural traditions, also was important to the literary development in Sweden as a critic. The literary leadership, however, belonged to Heidenstam, who spent several years in southern Europe and in the Orient, studying art and the history of culture before he published, at the age of twenty-nine, his first collection of poems, *Ur Vallfart och vandringsår* (1888) ("Pilgrimages and Years of Wandering"), which aroused immediate admiration. His glorification of youth and beauty, the pleasure of the moment, and the unlimited power of love fascinated a generation which had been taught to admire utilitarian ideals and an art dependent on observable fact. Heidenstam regarded naturalism as a literary method that belonged to the past, and he felt that a new aesthetic must be ushered in if Swedish literature was to retain its vitality and significance. Sweden, in Heidenstam's opinion, actually needed an entirely new national literature. A movement toward this goal has been characteristic of the literary development in Sweden since 1900, and in it Heidenstam's influence has been strongly felt. He published several historical novels, but despite his deep interest in the past, he was never guilty of narrow antiquarianism. He explored Sweden's national past in order to interpret and, if possible, to direct Sweden's national present and future. One of the ideas most frequently recurring in his works is that the only solution to the many problems of his generation was the return to an essentially Classical spirit and point of view. In his opinion, some form of modern humanism was a philosophical and aesthetic necessity for the modern world.

In a letter to Heidenstam, Levertin said that Selma Lagerlöf's novel, *Gösta Berlings saga* (1891) was the "first work in accordance with Heidenstam-Levertin aesthetics," even though he was not quite sure of its qualities. Selma Lagerlöf, from childhood, had been the recipient of a rich store of local legends, but not until she had left her home province, Värmland, did she become conscious of the possibilities of its tales and legends as material for literature. Selma Lagerlöf was a born storyteller, able to fascinate her public, and gifted enough to rehabilitate the Swedish novel. The success of *Gösta Berlings saga* made it possible for her to travel around the world. *The Miracles of Anti-Christ* (1897) is a description of Italian village life, and at the same time an expression of the author's interest in social problems. In *Jerusalem* (1901-1902), she told a story for which she could use provincial Sweden as well as the Orient as a background. In 1908 Selma Lagerlöf moved back to Värmland and settled down in her old home for the remainder of her life. Her subsequent production was very rich, and its delicate art and warm humanity confirms, if it does not add to, the reputation she won for *Gösta Berling* and *Jerusalem.*

Heidenstam's ideas also inspired Gustaf Fröding (1860-1911), a Swedish newspaperman, to make his first appearance as a poet. Unexcelled as a master of form, Fröding inaugurated a renaissance in Swedish poetry. His poetry covers a wide field, which includes folk life in Värmland, his home province, and a brooding over moral and religious problems. Erik Axel Karlfeldt (1864-1931) converted the old peasant civilization of his home province, Dalecarlia, with its echoes of Biblical and folk wisdom, into great poetry. Pelle Molin (1864-1896) represented north Sweden. The last one of the great generation of the 1890's was Per Hallström (1866- ). He often painted life in dark colors, but some of his best works are rich in genuine Romanticism.

**Twentieth Century.** In speaking of the 1880's and the 1890's as two great periods in Swedish literature, it should be remembered that some of the foremost representatives of these two periods created many of their best works in the twentieth century, when they also became more widely read and recognized. The social development of the time allowed a greater literary interest among the common people, and the national movement, represented in the 1890's by Verner von Heidenstam, included a new interest in folk culture and regional history, and also efforts to make the national treasures in literature and arts available to the common man. Temperance and religious activities were other details of the nationwide idealistic movement. A typical representative of the combination of an interest in folk culture and a general social sympathy is Karl Erik Forsslund (1872-1941), whose novel *Storgården,* a modern variation of Rousseau's theories, was widely read. Forsslund founded a people's high school at Brunnsvik, where later a whole generation of intellectuals from the working class completed their education, many of them becoming poets and novelists.

The labor movement, in its early stages, produced no poets of importance. Younger poets and novelists of the new century had a pessimistic outlook and a *fin-de-siècle* philosophy, influenced from abroad. Typical representatives of this group are Hjalmar Söderberg (1869-1941) and Bo Bergman (1869- ), both Stockholm writers. In southern Sweden a contemporary group followed the traditions of Ola Hansson, among whom Vilhelm Ekelund (1880- ) and Anders Österling (1884- ) should be mentioned. A movement toward realism and a greater interest in social problems set in around 1910. A forerunner of this movement was Albert Engström (1869-1940), who criticized the artificial psychological interest of his colleagues and pictured life in Småland. Ludvig Nordström (1882-1942), like Pelle Molin, was a literary representative of north Sweden. Hjalmar Bergman (1883-1931) capitalized on his knowledge of life in central Sweden in his novels. Sigfrid Siwertz (1882- ) also belongs to this group. His writings are intellectual and reflect Swedish contemporary life. This is also true of Gustaf Hellström (1882- ), who during his many years as a newspaper correspondent in foreign countries has been interested in psychological and sociological problems. Selma Lagerlöf's place in the Swedish Academy was taken by Elin Wägner (1882-1949), who painted colorful pictures of the early years of women's emancipation in Sweden. In her later novels, Elin Wägner's interest shifted to moral problems.

Martin Koch (1882-1940) gave Swedish literature its first thorough portrayal of the working class and its special conditions of life. In trying to picture the lives of individuals, he also wanted to write novels concerning the history of the community. The same ambition is typical of the self-educated radical politician and writer Fabian Månsson (1872-1938). The influence of World War I on Swedish literature is especially recognizable in efforts toward a deeper understanding of the problems of the time, characteristic of an entire group, and it is the more significant in that many of the group had begun as dilettantes influenced by *fin-de-siècle* motifs in Scandinavian literature. This development has also contributed to a better appreciation of the entire "group of the 1910's," which, to a great extent, had been overshadowed by the authors of a previous generation. Some of the poets in the period after World War I tried to express the "agony of life" felt in a world torn by war and disaster. Several of them turned to religion, hoping there to find a solution of their problems; to others the creative forces of life, true love, duty, home, and tradition became sources of inspiration. Sometimes these poets have been criticized for having cultivated the idyl for its own sake, but the seriousness of their attitude cannot be doubted. During the 1920's they were opposed by a group of authors from the working class, who cared less for tradition and cultural heritage than for the right of spontaneous life and the satisfaction of primitive instincts. Of the group from the 1920's, Birger Sjöberg (1885-1929), Dan Andersson (1888-1920), and Erik Lindorm (1889-1941) should be mentioned. To the group of poets for whom sober reality and the greatness of everyday life are the sources of inspiration belong Karl Asplund (1890-1949) and Gunnar Mascoll Silfverstolpe (1893-1942). Sten Selander (1891- ) stands between this group of lyricists of the 1920's and a group of authors whose works almost exclusively concentrate upon the discussion of philosophical ideas. Among the latter, Pär Lagerkvist (1891- ) and Erik Blomberg (1894- ) should be mentioned.

After World War I interest in literature grew steadily in Sweden. Adult education received more support and the number of libraries increased. Literary interest among the working classes became apparent, and most of the new authors in the 1930's were young workers lacking college or even high school education. Several of them, however, spent some time abroad and received deep impressions of foreign literature. Psychoanalysis was their favorite science; it served as an arsenal for their opposition to old forms and conventional ideas. Discussion of social, religious, and cultural problems was intense during the first years of the decade, but it was later overshadowed by the threat of World War II. One of the most colorful authors was Agnes von Krusenstjerna (1889-1940), whose intensity and interest in the psychology of the abnormal recalls Hjalmar Bergman. A more intellectual and broadminded psychologist was Eyvind Johnson (1900- ), who in his autobiographical novels provided a study of the psychology of youth unsurpassed in Swedish literature. Among the authors of the same generation who depict life in the Swedish countryside, Vilhelm Moberg (1898- ) holds first rank because of his honest, reliable, and naturalistic portrayal of the peasantry. Ivar Lo-Johansson (1901- ) added to Swedish literature a Swedish farm laborers' epic, written with passion and strength, a realistic description of a proletarian background. Helga Martinson (1890- ) and Jan Frigegård (1897- ) also belong to this group. The group of authors who called themselves "the five young ones" who, about 1930, prophesied a new and better era, the age of a generation free from complexes, began as modernistic poets, but seemed in spite of their program, to be more at home with the idyl than with the trappings of the machine age. This is especially true of Harry Martinson (1904- ), who sketched life at sea and in harbors in prose unsurpassed in modern Swedish literature. The leader of the group was Artur Lundkvist (1906- ) whose enthusiastic praise of the joy of life is in contrast to the pessimism and inharmonious feelings met in poets such as Birger Sjöberg, Bertil Malmberg, and Pär Lagerkvist. Hjalmar Gullberg (1898- ) has felt the agony and pessimism of two world wars. His deep feelings and intellectual skepticism give his enthusiasm and irony a richer register than most of the writers of his generation. Influences from American modernists inspired the generation of the 1940's to literary experiments which promised to inaugurate a new development.

The Romanticism in Finland's Swedish literature, represented by Topelius, was broken by Karl A. Tavaststjerna (1860-1898), who was influenced by Henrik Ibsen and Strindberg. The literary development after Topelius and

Tavaststjerna remained dependent on the political development of the time. Authors and poets felt it their duty to defend Finland's cultural traditions against Soviet pressure. The competition between the two official languages in Finland—Swedish and Finnish—has also been strongly felt. Hjalmar Procopé (1868-1927) was the oldest of a group of gifted poets embodying Swedish traditions from the 1890's. Bertil Gripenberg (1878-1947) represented the province of Tavastland (Häme). Arvid Mörne (1876- ) represented the province of Nyland (Uusimaa), and Jakob Tegengren (1875- ), the Swedish-speaking province of Österbotten (Vaasa). Among the novelists, Runar Schildt (1888-1925) might be mentioned, and Jarl Hemmer (1893-c. 1944) discussed ethical problems in his poetry as well as in his novels. Modernistic trends were represented by Edith Södergran (1892-1923) and Elmer Diktonius (1896- ). *See also* Almqvist, Carl Jonas Love; Andersson, Dan; Bellman, Karl Mikael; Fröding, Gustaf; Heidenstam, Verner von; Kellgren, Johan Henrik; Lagerlöf, Selma Ottiliana Lovisa; Runeberg, Johan Ludvig; Söderberg, Hjalmar; Södergran, Edith; Strindberg, August; Tegner, Esaias; Wallin, Johan Olof. A. Wi.

**SWEET, HENRY** (1845-1912), English phonetician and philologist, was born in London, Sept. 15, 1845. He began an independent study of Old English in 1863 and of phonetics in 1868, meantime studying at King's College, London, at Balliol College, Oxford, and at Heidelberg University. Later he edited some of the most important Old English texts for the Early English text society: King Alfred's *Cura Pastoralis* (1871), *Orosius* (1882), and the *Oldest English Texts* (1885). From 1873, he produced books which laid the foundation of modern phonetics (*History of English Sounds,* 1873; *Handbook of Phonetics,* 1877; and other works) and of formal instruction in Old and Middle English (*Anglo-Saxon Reader,* 1876; Middle English primers in 1885 and 1891; and other highly competent texts). He also wrote important works on the history of English and on general linguistics. Sweet was intensely disappointed when his two applications for a professorship at Oxford (1885, 1901) proved futile; Oxford granted him only a readership in phonetics (1901). His practical work in phonetics continued throughout his life. He died at Oxford, Apr. 30, 1912. C. R. Sl.

**SWEET ACACIA** [ə-ke′shə], a plant, *Acacia farnesiana,* whose flowers are used in France in the making of perfumes. Native to tropical and subtropical America, it is naturalized throughout the warm regions of the world. A branchy, spiny shrub, or small tree, growing to about 12 ft. high, it is of the mimosa group in the pea family. It bears finely divided leaves and small globes of deep-yellow flowers with only the numerous stamens showing. The sweet acacia is also known as opoponax, popinac, cassie, and, in Mexico, huisache. J. C. Wis.

**SWEET BAY,** an attractive species of magnolia, *Magnolia virginiana,* native from Massachusetts to Florida and Texas. It is a shrub or tree growing as high as 60 ft., and has fragrant, creamy-white flowers in late spring. In the Old World, the name of this species is applied to the true laurel, *Laurus nobilis.* J. C. Wis.

**SWEET BRIAR COLLEGE,** an accredited, privately controlled college of liberal arts and sciences for women. The buildings and grounds occupy nearly 3,000 acres of land in the small rural community of Sweet Briar, Amherst Co., Va. The charter was granted in 1901 and first instruction was offered in 1906. Only the A.B. degree is offered. The junior year of study may be taken abroad in France and Switzerland under the foreign-study plan of the University of Delaware, or at St. Andrews University in Scotland. The extensive library contains a noteworthy collection of the works of George Meredith. All students, except residents of Amherst Co., live in the college dormitories. Special aid is given to a limited number of foreign students, and residents of Amherst Co. receive free tuition. The opportunities for self-help are limited. There are no sororities. *For statistics see* Colleges and Universities. J. R. To.

**SWEETBRIER,** a large vigorous species of rose, *Rosa eglanteria,* called also eglantine, native to Europe. The foliage is fragrant. This rose is naturalized throughout eastern North America. J. C. Wis.

**SWEET CLOVER,** common name of a genus, *Melilotus,* of erect fragrant herbs of the pea family, also called melilot. All of the approximately 30 species are natives of the Old World, but some are widely naturalized in fields and along roadsides in North America. One of the best known of these is the white sweet clover, *M. alba,* which grows across the United States and is widely sown, under the name Bokhara clover, for green-manuring, for forage, and as a cover crop. It is a biennial growing 3 to 10 ft. high, and has fragrant leaves, divided into three small leaflets, and many slender spires of small white flowers which are a fine source of honey. The annual yellow melilot, *M. indica,* from Asia, is a smaller plant having yellow flowers, much grown in California, and widely naturalized. The larger common yellow sweet clover, *M. officinalis,* of Europe and Asia, is also widespread in North America. E. R. C.

**SWEET FLAG,** common name for an aromatic perennial species, *Acorus calamus,* of the arum family, growing in swamps and along streams throughout eastern North America, in Europe, and in Asia. The leaves are linear and pointed, from 2 to 6 ft. in height, and the tiny, greenish-yellow flowers are produced in early summer on short spikes projecting laterally from leaf-like stalks. In North America, the plant rarely produces fruit. The horizontal branching rootstock serves as a means of propagation, and its highly aromatic character makes it useful in medicines, flavorings, and perfumes. J. A. Bo.

**SWEET GALE,** called also sweet willow and bog myrtle, an aromatic shrub, *Myrica gale,* of the sweet-gale family, native to wet, peaty soils throughout the arctic and cool temperate regions of the Northern Hemisphere. It grows 2 to 5 ft. tall, bearing narrow, wedge-shaped leaves dotted with resin, and small flowers in short, dense catkins which appear before the foliage does. The yellowish fruit is resinous, but, unlike the fruits of the closely related bayberry, has no wax coating. The sweet gale is an emblem of the Scottish clan of Campbell. *See also* Wax Myrtle. J. C. Wis.

**SWEETGUM.** *See* Liquidambar.

**SWEETLEAF,** a partially evergreen tree, *Symplocos tinctoria,* of the sweetleaf family, found in moist, shady places from Delaware to Florida and Louisiana. It grows as high as 30 ft. The narrow, oblong leaves, lustrous above and silvery-white below, are greedily eaten by cattle and

horses because of their sweet taste, which gives the tree the alternate name of "horse-sugar tree." In spring, there are profuse clusters of fragrant yellowish flowers. A yellow dye is obtained from this tree. W. D. B.

**SWEET PEA,** a slender climbing annual, *Lathyrus odoratus,* of the pea family, grown in gardens and under glass for its delicate, fragrant flowers carried on long, slim stalks. Native to southern Europe, the sweet pea was first cultivated in Sicily in 1699. Years of selective breeding by many growers have produced sweet peas ranging from white through pink, red, yellow, and blue, with variations in the ruffling of the flowers, in the height of the plants, and in time of bloom. The dwarf sweet pea, var. *nanellus,* is a low plant which succeeds in climates too hot and too dry for the six-foot, tendril-climbing varieties. The development of a winter-flowering strain for greenhouse cultivation has given the sweet pea a place among the five leading commercial cut flowers. The production of sweet pea seed is a California industry. J. C. Wis.

**SWEET POTATO,** *Ipomoea batatas,* a perennial of the morning-glory family, grown for its edible tuberous roots. Some botanists think this plant is native to the Old World; others maintain that it may be a cultigen of *I. tiliacea,* a closely related species native to tropical America. The creeping stems bear long leaves and rose-violet or pale pink flowers. The plant requires fertile land of good tilth. It is widely cultivated in warm regions and in the United States is grown commercially from New Jersey southward and westward to Southern California. It is often erroneously called the yam. V. A. T.

**SWEETSOP,** a small tree, *Annona squamosa,* of the custard-apple family, growing 10 to 20 ft. high, and bearing oblong leaves and greenish-yellow flowers. The fruit is about the size of an orange, smooth, somewhat globular, and yellowish in color. It has a sweet, custardlike flavor. This tree, which is also called the sugar apple, is native to tropical America; its fruit is used in making preserves and jellies, and for this reason it is widely cultivated in warm regions. M. G. W.

**SWEET SULTAN.** *See* CENTAUREA.

**SWEET VERNAL GRASS,** *Anthoxanthum odoratum,* a perennial, native to Europe and Asia but now naturalized in all parts of North America. The erect, 2-ft. stems bear short leaves and spikelike flowering panicles. It is often planted with other grasses for the fragrance (due to coumarin) which it yields when dry. J. C. Wis.

**SWEETWATER,** a city and resort in north central Texas, the county seat of Nolan County, situated 176 mi. southwest of Fort Worth in an agricultural and livestock area famous for its Hereford cattle. The city is a cattle-shipping, trade, and distribution center for the entire county. Gypsum is a natural resource of the region. Sweetwater was founded in 1877 and incorporated as a city in 1895; it has the council-manager type of government. A historic feature in the vicinity is the ruins of Fort Chadbourne, established in 1853. The Sweetwater region is the locale of Dorothy Scarborough's novel, *The Wind,* dealing with the devastating drought of 1886 and 1887. Transportation is furnished by the Atchison, Topeka and Santa Fe and the Texas and Pacific railroads, and by the Pioneer Airlines. Railroad shops are important in the city's economic life. Industries include meat packing, oil refining, and the manufacture of cake and mixed feeds, gypsum products, cottonseed oil, and creamery products. Pop. 1950, 13,619.

**SWEET WILLIAM,** a perennial, *Dianthus barbatus,* of the pink family, closely related to the garden pink and native to Europe and Asia. Long a garden plant, it has become naturalized in parts of the eastern United States. Strong, erect stems, 1 to 2 ft. high, bear broad, pointed leaves, and close, rounded heads of flat, fringed flowers in red, purple, rose, or white. There are many horticultural forms, usually treated as biennials, including single and double varieties. Hybrids have been developed also with other species of *Dianthus.* In the middle western states, the name "wild sweet William" is applied to the native *Phlox divaricata.* E. L. Sh.

**SWEYN, SVEIN, SVEN,** or **SVEND** [svɛ′ɪn, svɛ′n], the name of three kings of Denmark.

**Sweyn I** (d. 1014). Though his father, Harold Bluetooth, had Christianized the Danes, Sweyn I, called Forkbeard, threw off Christianity and, after taking part in numerous Viking expeditions, deposed and killed his father in 986. Shortly after ascending the throne he was driven from Denmark by Eric, king of Sweden, and in 994 began his raids against England, compelling Ethelred the Unready to pay him tribute, but failing to take London. Eric having died in 995, Sweyn returned to Denmark and in 998 married Eric's widow, Sigrid, who persuaded him to form an alliance with the Swedish king, Olaf, against Olaf Tryggvesson, king of Norway. In 1000 the allies were victorious at the famous battle of Swold, off Rügen, at the same time conquering southern Norway. The massacre of Danes in England on St. Brice's Day, 1002, in which Sweyn's sister was killed, drew him once more to England, and by the end of 1013 he had conquered nearly the whole of that kingdom. Sweyn died suddenly at Gainsborough on Feb. 13, 1014. His conquests in Norway and England laid the foundation for the power of Denmark in the Middle Ages.

**Sweyn II, Estrithson** (d. c.1075). Sweyn II was the grandson of Sweyn I and the nephew of Canute the Great. After the murder of his father, Earl Ulf, by Canute (c. 1027), he fled to Sweden, where he remained until 1035, when he was named viceroy of Denmark by Magnus the Good, King of Norway. Magnus became king of Denmark in 1042 and, before his death in 1047, appointed Sweyn his successor to Denmark's throne. For 17 years Sweyn waged an inconclusive war against his rival, Harold III, called Hard-Ruler, heir to the throne of Norway, and twice, in 1069 and 1075, unsuccessfully attempted to invade England and seize the throne of that country. He was the founder of the Estrith Dynasty and five of his sons became kings of Denmark.

**Sweyn III** (d. 1157). Sweyn III was the son of Eric II, the Memorable. Brought up at the court of Conrad III, Sweyn succeeded to the throne of Denmark on the abdication of Eric III, the Lamb, in 1147. His entire reign was marked by struggles with the rival claimants to the throne, Canute V and Waldemar I. Though he succeeded in assassinating the former, he was himself defeated by Waldemar at the battle of Grathe Heath in 1157, and perished in his flight from the field. C. W. D.

**ŚWIDNICA** [shvidni′tsɑ] (Ger. Schweidnitz), an industrial city in Wrocław Department, southwestern Poland, 30 mi. southwest of the city of Wrocław. The former German city lies on the upper Weistritz River at the northeast

foot of the Eulen Range, part of the Sudeten Mountains, on the Czech frontier. Originating about the eleventh century, it received town rights in 1250 and was in the fourteenth century the capital of a partial principality of the Piast dukes. It passed to Prussia in 1741, was fortified by Frederick the Great in 1747, occupied by the Austrians (1757-1759, 1761-1762) in the Seven Years' War, and occupied by the French under Napoleon. It was later included in the Prussian province of Lower Silesia. In 1945 it was taken by Soviet troops and provisionally awarded to Poland at the Potsdam Conference. The Roman Catholic Parish Church, built between the fourteenth and sixteenth centuries, has a 328 ft. tower, one of the highest in Silesia. The town hall was first built in 1291, and rebuilt in 1717, while the Church of Peace was built in 1652. Świdnica has a museum containing articles associated with the noted German World War I flier, Manfred von Richthofen. The local factory output prior to World War II included electric clocks, radio supplies, machines, sporting goods, leather, furniture, and beer. The town was a trade center for grain, lumber, and cattle. Pop. 1946, 13,106. L. M. A.

**SWIFT, JONATHAN** (1667-1745), English author, was born in Dublin, Nov. 30, 1667, the son of an English family that had recently settled in Ireland. Though he wrote a considerable body of poetry, he is chiefly famous for his prose writings, and in particular for his brilliant and vigorous satires.

After leaving Trinity College, Dublin, he spent ten years, from 1689 to 1699, with several interruptions, in the household of Sir William Temple, Whig statesman and minor author, at Moor Park, forty miles from London, as confidential secretary. His duties left him time to read widely in Temple's excellent library. It was here, during the years 1696 and 1697, that he probably composed his first great satire, not published until 1704, *A Tale of a Tub*. Inferior to *Gulliver's Travels* in universality of appeal, it even surpasses *Gulliver* in sheer energy of intellect and in the telling vigor of its prose. He had been ordained priest in the (Anglican) Church of Ireland in 1695, and on Temple's death in 1699 he settled in his Irish parish at Laracor, about forty miles from Dublin. During the next ten years he lived in Ireland, with a number of protracted visits to England, serving on one of them as official representative of the Irish Church in some financial negotiations with the English government.

Swift was brought up a Whig; but he became convinced that under the Whigs the established Church was in danger. In 1710 he joined the Tories and for the next four years threw himself into the support of the Tory administration of Edward Harley and Henry St. John. His vigorous political writing and his shrewd political advice made him during these years one of the most influential men in all England.

With the death of Queen Anne (1714), the Tory Party fell from power and went into a long period of eclipse. Swift's career in English politics was at an end. To Swift and to his friends the ascendancy of the Whigs seemed a triumph of all the base and ignoble forces in English life. For such services as he had rendered, an eighteenth-century clergyman could expect to be rewarded by being made a bishop; but Swift received only an appointment as Dean of St. Patrick's Cathedral, Dublin.

A disappointed and embittered man, Swift, then forty-seven years old, took up his residence in his Dublin deanery where, with only two visits to England, he spent the remaining thirty-one years of his life.

Into his life there came an element of strange romance that has fascinated and baffled all students of his life and writings. During the years of his political prominence he had met a young woman of twenty, daughter of one of his London neighbors, named Esther Vanhomrigh, whom Swift called "Vanessa" in his writings. She fell desperately and passionately in love with him. Much against his wishes, she insisted on following him to Ireland, where she died in 1723, almost literally of a broken heart. More important is "Stella," Miss Esther Johnson. When Swift first knew her, she was living with her mother, housekeeper for Swift's employer Sir William Temple. She was a graceful child of eight, Swift a rather awkward youth of twenty-two. Among his duties was that of acting as tutor for the little girl, for whom Temple felt a deep affection. She grew up to be an extremely beautiful and gracious woman. Sir William died in 1699, and two years later the girl went at Swift's suggestion to Ireland, where she lived under Swift's care and protection until her death twenty-seven years later. To her he addressed during the years of his political activities the famous series of diary-letters, published after his death as *The Journal to Stella*. She was the closest and dearest of Swift's many close friends; but his affection for her was as sexless as that of an uncle for a gracious and charming favorite niece. By a punctilious observance of the proprieties—they were never alone together—the breath of scandal was turned aside; but rumor had it that they had been secretly married. This rumor, accepted as fact by many of Swift's biographers, seems to others an improbable story resting on very insufficient evidence. All, however, are agreed that Swift and Stella never lived together as man and wife.

For several years after his return to Dublin as Dean, Swift wrote nothing of consequence. Then in 1724 he emerged in the *Drapier's Letters* as an Irish patriot protesting against the economic bondage in which Ireland was held by her English overlords. In 1726 was published his most memorable work, *Gulliver's Travels*. Instantly popular, it has continued to be one of the most widely read books in English. It is a fascinating play of fanciful imagination and a profound satire on the essential unreasonableness of human behavior.

All his life Swift had been subject to periods of depression and to a haunting fear of insanity. After Stella's death in 1728 his gloom steadily increased. His last years were passed in a dreadful apathy, his mind clouded, his speech nearly gone. And there were periods of intense pain. He died on Oct. 19, 1745, at the age of seventy-eight, and was buried beside Stella in the nave of St. Patrick's Cathedral. The Latin epitaph, by Swift himself, contains the statement that he now is laid "where fierce indignation cannot any longer tear his heart."

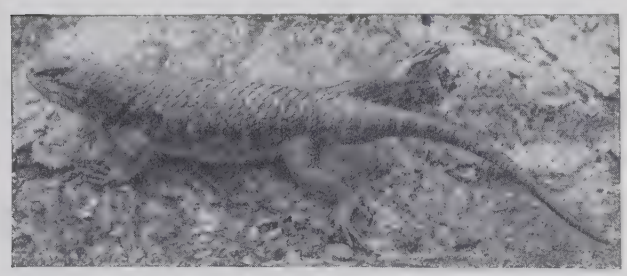
With brilliant wit and fertile imagination, in a prose style unsurpassed for its unadorned vigor, he indignantly lays bare the manifold corruption that lurks beneath the plausible surface appearance of men and their social behavior. In every one around him—even in his dearest friends and in himself—he sees the latent beast, and at the dreadful spectacle he tears his heart. If only, he seems to say, men could cease to be ruled by their mean and sordid passions and live by the clear light of reason! *See also* Battle of the Books, The; Gulliver's Travels; Tale of a Tub, A. R. K. R.

**SWIFT,** any one of a large number of species of small birds that form the family Chaeturidae. Although quite different in appearance, their nearest relatives are the hum-

mingbirds. They occur in temperate and tropical regions virtually throughout the world. They are characterized by a truly streamlined body with extremely long, narrow, backward-curved wings, a large mouth for capturing insects, and small, weak feet that can support them only while clinging by the claws to a vertical surface. In many ways they resemble the unrelated swallows, with which they are popularly confused. Their plumage is dull, usually combining such colors as browns, grays, black, and white, but in some cases showing a more or less metallic gloss. Most swifts build shallow, cuplike nests of twigs, affixed by a gluelike secretion of the salivary glands to the walls of caves, chimneys, or hollow trees. Their voices are shrill and grating. The members of this family are the most aerial of all birds; they eat and even drink while in flight. The wings are beaten with great rapidity, and some of the larger species of swifts are known to achieve for short distances a speed in excess of one hundred miles an hour. The North American members of this group vary in size from 5½ to 7½ inches in length. H. G. De.

**SWIFT CURRENT,** a city in Saskatchewan, Canada, on the Swift Current Creek, 110 mi. west of Moose Jaw. Located in a grain-growing and mixed-farming region, it is a commercial and distributing center for southwestern Saskatchewan. The Canadian Pacific Railway provides transportation for this industrial center, which includes among its industries four grain elevators, and a flour mill. A Dominion experimental farm is located near the city. There is a meteorological station situated in Swift Current. Pop. 1951, 7,458. L. G. R.

**SWIFTS,** a name loosely applied to various small, speedy, diurnal lizards. They are very hard to differentiate from one another, and they are hard to capture. There are four



VERNON BAILEY—U. S. FISH AND WILDLIFE SERVICE

*SWIFT, A LIZARD BELONGING TO THE GENUS* SCELOPORUS

genera of swifts. The rough-scaled swifts, *Sceloporus,* a genus with 102 members, has 27 representatives in the United States. They are found from British Columbia to New York, and south to Panama. They all are without a fold of skin across their throats; some of them are egg-laying, while others are live-bearing. The other three genera are also known as utas. They are all egg-laying, and all have a fold of skin across their throats. They are found in the western United States and in Mexico. The utas include 2 species of collared utas, *Streptosaurus;* 20 species of climbing utas, *Urosaurus;* and 11 ground utas, *Uta.* M. G. N.

**SWIMMING AND DIVING.** The art of swimming and diving, as practiced by man, dates back to prehistoric times. As a popular sport, however, its development did not begin until the late nineteenth century, when new strokes were introduced in competition. Developments since the turn of the century have classified swimming and diving as a distinct form of recreation and a competitive sport.

**Early History.** Prehistoric man began the development of swimming when he took to the water for the preservation of life, to cross unfordable streams, or to bathe for comfort. Literature and sculpture prior to A.D. 1500 supply many references showing that swimming was in common use among people of many races. The ancient Assyrian bas-reliefs, from the period about 880 B.C., show soldiers propelling themselves in the water by an overarm stroke resembling the modern crawl stroke. The Greeks and later the Romans, both physically active races, found swimming valuable training for military service and a healthy recreation during peace. When Leander conquered the Hellespont in A.D. 193, the coin of Abydos was struck off to commemorate the event. He used an overarm stroke, also popular with the Romans, that is believed to have come from the early Assyrians. Tales of other great feats of swimming are found not only in Greek and Roman Classics but in the early Scandinavian sagas, and in the first bit of English literature known, the epic poem *Beowulf.*

Plagues sweeping Europe during the Middle Ages discouraged swimming, since it was generally believed that outdoor bathing was a contributing factor in the spread of disease. The art did not vanish entirely, however, and European literature, beginning in the late sixteenth century, contains further references. During the next three hundred years there was considerable experimentation on swimming strokes. At first a breast stroke came into common use. This yielded in popularity to an underarm side stroke and various forms of an elementary backstroke. Finally, an overarm side stroke came into vogue and was employed extensively, particularly in England, until the turn of the twentieth century.

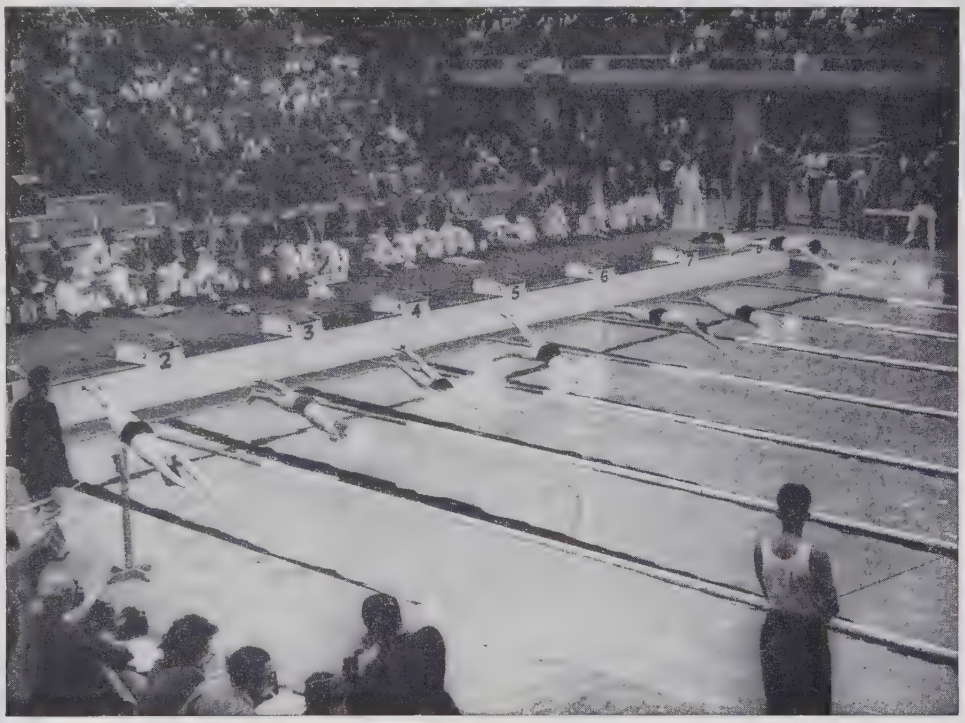
**Start of Competitive Interest.** The start of competitive activity in swimming stimulated public interest and an ever-increasing participation in swimming. It focused attention upon the form and style of various strokes, led to the revival of the ancient Olympic Games in 1896, and set in motion the great assault upon time records in the various accepted events and distances.

The Associated Metropolitan Swimming Clubs of London were organized in 1862 to promote competitive swimming. This group was the forerunner of the London Swimming Association, which later became the Amateur Swimming Association of Great Britain, with a total membership of three hundred clubs. Simultaneously, swimming gained in popularity in central Europe, Australia, and New Zealand. In the United States, the sport was given new impetus by the formation in 1888 of the Amateur Athletic Union, a "union of clubs" with the specific purpose of promoting amateur athletics, including swimming.

**Development of Strokes.** *Crawls.* The developing accent on speed led to the introduction in England in 1873 of a new hand-over-hand racing stroke. J. Trudgen, who first adapted the stroke, had learned it from the South American Indians. Because of the remarkable speed he was able to attain with it at sprint distances, the stroke caught and held the public fancy. It was essentially a crawl overarm stroke. The Australian crawl stroke came soon after. This was a slight modification of a stroke long used by the native South Sea islanders and was first introduced in competition in about 1900 by Richard Cavill, an Australian, who broke the existing world's record for 100 yd. with ease. The manner in which he seemed literally to "crawl over the water," according to sports accounts of

the race, established the name of the stroke in popular fancy.

After the Americans had turned serious attention to racing in the water, they modified the Trudgen and Australian crawl strokes and introduced a six-beat kick, combined with a double overarm stroke now commonly known as the American crawl. "Free style" means any style of swimming. It is the name for those competitive events in which any type of stroke may be used. Since the crawl stroke became the fastest method for getting through the water, it has become nearly synonymous with free style. In the crawl, the great free-style stroke of the champions, the position of the body is in a face-down float. The arms alternate in reaching out over the shoulder, while the leg drive is a continuous up and down thrashing motion from the hips down.



THE MEN'S 1500-METER FREE-STYLE FINAL AT THE OLYMPIC GAMES

INTERNATIONAL NEWS

*Backstroke.* The modern backstroke, or back crawl, is a combination of the overarm action with a flutter kick. It is actually an inverted crawl, involving certain adjustments, with the same co-ordination between the arm and legs, and is both powerful and speedy.

*Breast stroke.* The ancient and orthodox breast stroke, celebrated by Lord Byron in his poetry and believed by some to be the oldest of all strokes, was considerably speeded up by the introduction in 1935 of a "butterfly" racing adaptation by Henry Myers, an American. In this adaptation, recovery of the arms takes place out of the water, resembling somewhat the flapping of a butterfly's wings. In the older and considerably slower breast stroke, recovery of the arms takes place under the water.

**Olympic Games.** Only three swimming events were held at the 1st Olympiad at Athens in 1896; these were free-style races at 100, 500, and 1,200 meters. Races at various distances were held in the 1900, 1904, and 1906 games, but it was not until 1908 that the current Olympic swimming program was established: free-style races at 100, 400, and 1,500 meters; free-style relay at 800 meters; backstroke race at 100 meters; and breast-stroke race at 200 meters. The first American Olympic swimming champion was Charles M. Daniels, who won free-style races at 220 and 440 yards in 1904, and went on to win the 100-meter free style in 1906 and 1908; he remains the only swimmer ever to win four Olympic championships. For a decade after World War I the United States dominated Olympic swimming, winning 13 of a possible 19 titles at the 1920, 1924, and 1928 games. Japan, however, won five of six events in 1932, and three of six in 1936. America regained pre-eminence after World War II, winning 10 of 12 titles at the 1948 and 1952 games.

Women's swimming events were introduced in 1912 at the 5th Olympiad at Stockholm, but it was not until 1924 that the standard Olympic program (100- and 400-meter free style; 400-meter free-style relay; 100-meter backstroke; and 200-meter breast stroke) was established. Ethelda Bleibtrey, who won two races in 1920, was the first American woman to win an Olympic swimming championship. American women dominated the games from 1920 through 1932, winning 14 of 19 events in that time. The Netherlands, with four titles, was outstanding in 1936, while in 1952 Hungary won four of the five swimming events.

**Great Champions.** *Free Style.* The first great American free-style champion was the Olympian, Charles M. Daniels. Others who followed him include Duke Kahanamoku, Johnny Weissmuller, Norman Ross, Walter Spence, Peter Fick, Ralph Flanagan, Clarence L. "Buster" Crabbe, Otto Jaretz, Jack Medica, Keo Nakama, Alan Ford, Wally Ris, Bill Smith, Jim McLane, Ford Konno, Wayne Moore, and Clark Scholes.

*Backstroke.* Adolph Kiefer, who won his first national title in 1935 and was unbeaten in over 250 races in the next eight years, is the greatest of all backstroke stars. Other great American backstroke stylists are: J. H. Handy, Harry Hebner, H. Kruger, Wally Keloha, Albert Vande Weghe, George Kojac, Harry Holiday, Allen Stack, and Yoshinobu Oyokawa.

*Breast stroke.* Great American breast-stroke champions are: Michael McDermott, John Higgins, R. R. Hough, Bob Skelton, Jack Kasley, Joe Verdeur, and Jerry Holan.

EWING GALLOWAY

*The start of a swan dive*

*Women.* The first American woman to win international swimming honors was Ethelda Bleibtrey, the 100- and 300-meter free-style champion at the 1920 Olympics. Others who followed were: Ethel Lackie, Martha Norelius, Sybil Bauer, Helene Madison, Dorothy Burns, Agnes Geraghty, Eleanor Holm, Katherine Rawls, Gloria Callen, and Ann Curtis.

**Distance Swimming.** Long-distance swimming feats have helped to focus popular attention upon the sport. Capt. Matthew Webb, an Englishman who later died swimming the rapids below Niagara Falls, swam the English Channel on Aug. 24, 1875, the first person to do so. Since Webb, more than 50 persons have swum the Channel. The first woman to swim it was Gertrude Ederle, an American, who was the sixth person ever to swim the Channel and whose 1926 time broke all records up to that year. Florence Chadwick, another American, became in 1950 and 1951, the first woman to swim the Channel in both directions.

In 1940 John V. Sigmund of St. Louis swam 292 mi. nonstop in the Mississippi River in 89 hr., 42 min., the world's long-distance swimming record. Pedro A. Candioti of Argentina, another great distance swimmer, in 1935 swam 281 mi. nonstop down the Parana River in 84 hr.

**Development of Diving.** The development of competitive diving was an outgrowth of the upsurge of interest in swimming. It was early recognized that certain forms of plain diving are complementary to swimming and have definite uses, such as the ability to make a shallow or a deep plunge, to control the depth of the dive, and to level off into swimming position. The early history of competitive diving may be traced back to the seventeenth century, when formal gymnastics became popular in Germany and Sweden as a means of physical exercise and bodily development. Eventually, gymnasium apparatus was transferred to the beaches during the summer and gymnastics over water came into vogue. This was the beginning in Europe of fancy diving, which still may be considered as aerial acrobatics over the water.

*Olympic Events.* The first Olympiad at which fancy diving was included as an event was that held at St. Louis in 1904. High-tower diving was added four years later at London. As anticipated, Sweden and Germany dominated the early Olympic competition, although since 1920 the United States has won practically every diving event in both men's and women's divisions. In both springboard- and platform-diving events, the 1908 games provided that a certain number and type of dives be compulsory and that, in addition, a group of optional dives be performed.

Thereafter, additional dives were introduced and approved from year to year. These approved dives are arranged in six major classifications: (1) forward dives; (2) backward dives, the diver facing the board; (3) gainer dives, the diver facing the water but spinning backward; (4) cutaway dives, the diver facing the board but spinning forward after gaining distance by an outward spring; (5) twisting dives; (6) handstand dives, from the high tower or platform. M. P.

**SWINBURNE, ALGERNON CHARLES** [swɪ′nbərn; swɪ′nbɜrn] (1837-1909), English poet and man of letters, was born Apr. 5, 1837, in London, the eldest of the six children of Admiral Charles Henry and Lady Jane Swinburne. During his boyhood he lived chiefly at Bonchurch, on the Isle of Wight, and later attended Eton and Balliol College, Oxford, without graduating from either. In 1857, while still a student, he came under the spell of Dante Gabriel Rossetti, who dominated an admiring circle and who was then known chiefly as one of the Pre-Raphaelites. Swinburne's early work, much of it unpublished, indicates study and imitation not only of Rossetti and of William Morris, another friend, but also of older writers. His memory and his linguistic gifts, his diminutive figure and red hair, and, in general, his oddities of appearance and conduct soon drew curious attention to him. One observer's comment—"He's a cross between devil and the Duke of Argyll!"—is quoted by Henry Adams, who himself characterized Swinburne as "a crimson macaw."

After publishing an unnoticed volume of plays, *The Queen Mother and Rosamond* (1860), Swinburne won favor with a lyrical tragedy, *Atalanta in Calydon* (1865), modeled, like the later *Erechtheus* (1876), on the Greek drama. *Chastelard,*

*ALGERNON CHARLES SWINBURNE*

BROWN BROTHERS

also published in 1865, was the first of three dramas devoted to the romantic career of Mary Queen of Scots, *Bothwell* (1874) and *Mary Stuart* (1881) rounding out the trilogy. Though more successful than some of the later plays, *Chastelard,* like several others, would have seemed more at home in the Elizabethan than in the modern theatre.

The contemporary comments on *Chastelard* were by no means entirely friendly, but *Poems and Ballads* (1866), because of its pagan treatment of sex and religion, stirred up a veritable tempest. It is hardly too much to say that this book

affected the poet's reputation for a lifetime. Though the poems may not now seem shocking, Swinburne did offend in giving expression—partly disguised, to be sure—to his eccentric sexual sensibility. Readers are still impressed by the color and splendor of language, the imaginative power, and the sweeping rhythms of this volume, but most critics agree that *Songs before Sunrise* (1871) and *Poems and Ballads: Second Series* (1878) have greater merit. The former was dedicated to Giuseppe Mazzini and, like *A Song of Italy* (1867), was partly inspired by that Italian idealist, who was to rank with Walter Savage Landor and Victor Hugo in the poet's trinity of heroes. The book hails the liberation of Italy, envisions the ideal republic, and pays tribute to "the holy spirit of man" incarnate in successive generations and achieving progress in an atmosphere of freedom. Positivism and the theory of evolution contributed to Swinburne's philosophic outlook, but even readers unsympathetic with both must applaud the lofty ethics of *The Pilgrim*. In the second series of *Poems and Ballads,* such poems as *At a Month's End* and *Ave atque Vale,* the latter an elegy in honor of Charles Baudelaire, one of Swinburne's early masters in the art of poetry, are among their author's metrical triumphs.

After 1879 Swinburne lived in virtual retirement at The Pines, Putney, with Theodore Watts, later Watts-Dunton. Of his numerous later works, the two Arthurian poems, *Tristram of Lyonesse* (1882) and *The Tale of Balen* (1896), are especially notable. Some of his later literary ballads and poems honoring friends and little children are also pleasantly readable, but as the poet grew older and more conservative, critics complained, and not without reason, of his growing thinness of substance and lack of humanity.

Swinburne devoted much effort to literary controversy and criticism, the best of which includes *Essays and Studies* (1875) and *Miscellanies* (1886). Here, however, extravagant praise, violent invective, and some unfortunate tricks of style tend to obscure the critic's learning, fine taste, and genuine insight. Swinburne's most significant attainment was, however, his poetic craftsmanship, and upon his death on Apr. 10, 1909, his position among the great English lyric poets was secure. C. K. Hy.

**SWINDON,** a railway junction and municipal and parliamentary borough, in Wiltshire, England, situated about 77 mi. west of London. It is composed of the old town, said to have been founded by Sweyn I, father of Canute, and the new town, which grew up around the locomotive and car shops built on waste land. The two were combined when Swindon was incorporated in 1900. In addition to the railroad shops, electrical machinery and aircraft parts are manufactured. The town is a market center for the nearby agricultural districts. Pop. 1954, 68,850. A. W.

**SWINE,** a term used to designate all domestic animals commonly referred to as pigs and hogs. Zoologically, swine are classed as hoofed mammals of the family Suidae. They are stout-bodied, short-legged, artiodactyl animals with omnivorous habits. The meat of swine, known as pork, is in all forms an important part of the diet of people throughout the world.

## HISTORY

**Fossil History.** In all probability, man's first use of swine occurred during the Neolithic age, or before written history, when swine were found of the type known as turbary or Asiatic pigs. They were small, much valued for food, and were able to withstand winters because they existed on woodland diets. Chinese history relates that hogs were domesticated about 4900 B.C. Swine are mentioned in Biblical historical writings as early as 1500 B.C., while legendary and historical accounts mention the keeping of swine in Great Britain as early as 800 B.C.

Fossil remains of the ancestors of the present-day hog have been found in the Pliocene strata of Europe and Asia and in the Eocene strata of North America and Europe. Fossil remains of a prehistoric relative of modern pigs have been found in Nebraska. The domesticated hog of today is closely related to the wild hogs that are found in various parts of the world. These wild hogs are of various types, including the pigmy hog of Nepal, the bush pig of Africa, and the peccary of North America. There is reason to believe that the wild hog originally looked much like the domesticated hog of today. These early hogs were gregarious, forming large herds; muscular, with inferior meat; and fierce fighters, with large tusks. Young pigs were almost invariably striped with bands of dark brown on the body, much the same as young wild pigs are today.

**Origin of Domesticated Swine.** The domesticated hog appears to have had an origin that involves the crossing of several distinct species or races. Swine were domesticated in several regions of the world. Early explorers found domesticated hogs in the South Sea Islands. The domestication of hogs seems to have been universal, for nearly all countries possessed them and developed a characteristic type of hog.

Although the exact origin is obscure, it is generally accepted that the domestic hog of today descended from the European wild boar, *Sus scrofa,* and the first improvement was brought about by the Neapolitan, Siamese, and Chinese crosses (*Sus indica*). The scrofa, or wild boar, has been known in Europe, Africa, and Asia. Varieties existed on every continent except Australia and America. The wild boar is noted for its strength, vitality, vigor, activity, slow maturing, and long life. It has large, heavy shoulders, long head and snout, short back and loin, and long legs. The skin is thick, with long bristles. Prolificacy and apparent immunity to disease are outstanding features of this species.

The *Sus indica* is a wild, parental form of which little is known. This species includes swine of China, Japan, and eastern Asia. In general, it is small in size, short legged, early maturing, rapidly fattened, smooth coated, and quiet in disposition. This species, however, was not so prolific as the scrofa. The Chinese hog was predominantly white and black, or all white; the Siamese was black.

The Neapolitan, *Sus wadituaneus,* a breed from Italy, was introduced into England. It was of grayish-black color and was used to improve the English swine. The predominant colors of the modern English hog are white and black, no doubt influenced by the Chinese white hog and the black Neapolitan.

Present-day breeds vary in color and color patterns, size and general conformation, appearance of head and ears, prolificacy, early maturing, symmetry, feeding qualities, and quality of meat. Careful selection, feeding, and breeding have been the main contributions to the development of the modern swine. However, the domestic hog will revert to type if placed in a suitable environment. Large numbers of wild pigs are found in remote districts of the United States, Queensland, Wales, and New Zealand. In each case they have reverted from the domestic type. The so-called "razorback" is a typical example of this retrogression.

Leading swine countries are located in the Temperate Zone, even though swine were originally found in tropical countries. China has the largest population, but chiefly for domestic consumption. The leading countries in swine pro-

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*A CHESTER WHITE BOAR*

COURTESY OF THE U. S. DEPARTMENT OF AGRICULTURE

*A YORKSHIRE SOW*

duction are: China, the United States, Brazil, the Netherlands, Germany, the U.S.S.R., France, Poland, Spain, Denmark, Canada, Argentina, England, Mexico, and Italy. The most important countries competing for world trade are Denmark, England, the United States, Germany, Poland, and the Netherlands.

**Swine in North America.** Columbus is credited with bringing hogs to North America. Spanish explorers brought them to Mexico, and Hernando De Soto is credited with introducing hogs into the United States.

The colonists settling along the eastern seaboard soon made pork production a source of income. As production exceeded domestic needs, pork and lard became available for export. The first recorded exports were to the West Indies in the year of 1790, and amounted to 6,000,000 lb. The Midwest expanded rapidly as a hog-growing area. Cincinnati developed into a large pork-packing center around 1840. Tennessee, Kentucky, and Ohio became the leading producers of swine. With the development of the railroads, and later of refrigeration, pork-producing areas moved farther westward into Illinois, Iowa, and Nebraska. After the Civil War (1870), exportation of lard and pork increased, and the larger population in the United States encouraged a steady increase in the production of pork until 1923. Since 1923 pork production has fluctuated, but the trend has been steadily upward, so that approximately 65,000,000 hogs were marketed in 1949. The corn belt produces 54 per cent, and the cotton belt approximately 22 per cent of the total population of hogs. The leading states in hog numbers are Iowa, Illinois, Indiana, Missouri, Ohio, Minnesota, Nebraska, Texas, Georgia, Wisconsin, North Carolina, Alabama, Tennessee, Kansas, and Mississippi.

Swine breeds raised in the United States are classified as follows: lard types—Berkshire, Chester White, Duroc-Jersey, Hampshire, Poland China, Spotted Poland China, Cheshire, Essex, Kentucky Red, Berkshire, Suffolk, and Victoria; bacon types—Yorkshire and Tamsworth.

The lard types of swine are developed in the United States to meet a need for the demand of lard. The breeds developed originated from stock imported from England, China, Spain, and Portugal. The bacon type of hogs are of English origin and are noted for their minimum production of fat to the maximum amount of lean meat. As the demand for lard decreased, both in the domestic and foreign trade, the lard hogs changed from overabundant producers of lard to types with a minimum amount, never, however, quite reaching the status of the true bacon hogs.

## HOG RAISING AND BREEDING

**Feeding.** The hog is distinctive in that the feeds used are largely concentrates. Pasture and roughages usually represent but a small portion of nutrient intake. The digestive tract of swine is simple and not adapted to the utilization of large quantities of fibrous material; therefore concentrates are deemed important. However, roughages and pasture help make the rations more economical and, in addition, supply the necessary minerals, vitamins, and proteins.

Corn is the basic feed for swine production. It is economical to produce and is high in carbohydrates. Other cereal grains and byproduct feeds can be used efficiently as the base

COURTESY OF THE U. S. DEPARTMENT OF AGRICULTURE

*A DUROC-JERSEY SOW*

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*A POLAND-CHINA BOAR*

of a ration for swine. Corn alone cannot be fed economically to swine, for it is deficient in minerals and vitamins, and low in protein. High-protein supplements, such as meat scraps, fish meal, soybean meal, linseed meal, and tankage, are utilized with the corn. Alfalfa meal is a standard part of a ration for swine fed in drylot because it contains vitamin A and protein. Oats, wheat middlings, wheat bran, flour, and many other feeds are all utilized by swine.

Products from the dairies, such as whole milk, skim milk, buttermilk, and whey, sweet or sour, are excellent as part of a ration for swine. Root crops of various kinds, particularly cull potatoes which have been cooked, may be used.

G. W. V. N.

### WILD SWINE

Wild swine are various species of swine belonging to the genus *Sus*. All have a long, projecting snout, with the nostrils at the end, which is used for turning up the soil in search of roots. In body form, wild swine are heavy and massive; nearly naked, or only sparingly haired; and the ears are large and flapping. The upper canine teeth, especially in the males, are generally long, flattened, and slightly curved upward, thus forming offensive weapons. The feet are narrow and cloven. Although the European wild pig has become almost extinct, several species are found in India, Malaysia, and some of the East Indian islands, as well as in Africa. The Indian wild pig, *S. cristatus,* is of great size, while the pigmy hog, *S. salvanius,* of Bhutan, is scarcely larger than a rabbit. G. M. C.

**ŚWINOUJŚCIE** or **SWINEMÜNDE** [shvi′nɔu′ɛshtshɛ, svinəmü′ndə], a port and seaside resort, located about 300 mi. northwest of Warsaw at the extreme northwestern tip of Poland on the northern coast of Uznam Island, facing the Baltic Sea. It lies above the mouth of the Swine River, which is the 10-mi. long outlet of the Oder River. The city was founded in 1740 on the site of a former fishing village and was fortified in 1765. Close to the border of Germany, it is the outer port for the city of Szczecin (Stettin), and its harbor is protected by breakwaters, 2 mi. long. During World War II, Świnoujście was used by the Germans as an experimental rocket station and was heavily bombed a number of times. At the close of the war, it became a Polish city when the island of Uznam was assigned to Poland by the Potsdam Conference of 1945. Shipbuilding, lumbering, and furniture making are the chief occupational pursuits. Pop. 1946, 15,587. L. M. A.

**SWISS CHARD,** a variety of garden beet grown as a leafy vegetable. The fleshy leaf-stems may also be cooked in the same manner as asparagus. *See also* BEET; CHARD.

V. A. T.

**SWISSVALE,** an industrial borough in western Pennsylvania, in Allegheny Co., situated near the Monongahela River, 8 mi. southeast of Pittsburgh. It was incorporated as a borough in 1897. Transportation is furnished by the Pennsylvania Railroad. Manufactures include steel, chains and cables, switches and signals, glassware, forgings, alloys, and electrical equipment. Pop. 1950, 16,488.

**SWITCHGEAR, ELECTRICAL,** devices for making and breaking contact between the source of electric power and devices which utilize it. Many of the devices employed are automatic in character, being actuated by the current or voltage in the circuit itself. The devices used range from the simple switch to complex assemblies of switchboards and control equipment.

### SWITCHES

Electric switches are devices for closing and opening circuits, thus permitting current to flow or be interrupted, and for changing connections in circuits. They have a great variety of uses, the number of poles, type of contacts, number of breaks, and method of action and control being designed to fit the special needs of the service.

**Lighting Switches.** Switches for the operation of electric lights and various household appliances and small motors are made in a variety of forms, such as snap, rotary, tumbler, or push-button. These have a rapid make-or-break produced by a spring-and-cam mechanism. They are totally enclosed and have ratings from 5 to 30 amp., 125 and 250 volts, and are available in single-pole or double-pole and up to three-way or four-way circuits.

**Knife-Blade Switches.** Knife-blade switches are adapted to control of circuits of moderate-power capacity and low voltage. One or more copper blades are hinged between stationary terminals at one end, while the other end engages two or more stub members which are given a spring action, so that they press tightly against the blades and ensure a good contact. The stubs are connected to stationary terminals. The blades are swung by hand to engage or disengage. For the heavier currents, 400 amp. and above, the switches may be provided with silver-to-silver line-pressure contacts in order to give better sliding contact surfaces. They are available in single-pole, double-pole, triple-pole, and four-pole construction and may be of either single or double throw. The power ratings range all the way from 30 amp., 125 volts, d.-c. and a.-c., to 6,000 amperes, 600 volts, d.-c., and a.-c. Normally knife switches are mounted on insulating panels or switchboards.

For 600 volts and 200 amp. or more, the switches must be of the quick-break type, in which the movement of the contact blade is independent of the operator's control. This result is obtained by means of an auxiliary blade, fastened to the main blade by a hinge and spring and independent of the switch handle. When the main blade is withdrawn, the auxiliary blade stays closed until the spring tension snaps it open, thus securing a rapid break and reduced arcing.

**Disconnecting Switches.** Disconnecting switches, generally used on circuits above 750 volts, are heavy slot-blade devices, built like knife switches, which are used to isolate equipment and circuits from the voltage source so that these may be handled safely for inspection and repair. They are also used to transfer circuits, as, for example, from one bus to another, to a special test bus, or to a ground connection. They do not operate under load current but are opened only after a circuit breaker has interrupted the power current. They are made single-pole with single or double throw. Individual switches may be grouped together and be operated as a unit, e.g., three units for a three-phase circuit. Indoor units have current-carrying capacities of 400, 600, 1,200, 2,000, 3,000 and 4,000 amp. for voltages up to 23,000.

The switch must carry the maximum overload current of its circuit for one hour and up to 50 times its normal current rating for five seconds. The supporting insulators for indoor service should stand a voltage test of 2¼ times rated voltage plus 2,000 volts for one minute, and outdoor units, when wet, should stand a test of twice rated voltage plus 1,000 volts, by American Institute of Electrical Engineers (A.I.E.E.) standards. Because of the strong magnetic field in the switch when it is carrying heavy currents which might force the blade open, it is provided with a strong positive latch. This latch must be released when the wooden insulating pole, called a hookstick, is inserted in the eye of the latch to open the blade.

Outdoor units for sectionalizing high-voltage bus bars are provided with horn gaps so that the arc will rise on the horns from its own heat and will finally break when the arc length exceeds that which the voltage can maintain. They are also used to isolate circuit breakers and ground the transmission lines for test.

The smaller disconnecting switches, either single or in groups, are opened and closed manually, but motor or pneumatic control is generally used for heavy-duty and high-voltage units.

**Control Switches.** Control switches, usually drum or rotary type with multiple contacts, control from the switchboard (1) operating motors or solenoids for circuit breakers; (2) motor-operated governors on prime movers; (3) motor-operated rheostats to raise or lower generator voltage; and (4) other devices. The currents handled are small, ordinarily not more than 10 amp. If greater current is required in an operating solenoid or motor, an auxiliary relay is employed to link the control circuit through to the actual operating power supply. The contacts are insulated for 600 volts. For circuit-breaker control, they are associated with pilot lamps in the switchboard panel, which show red if the circuit is closed and under potential, but show green if the breaker is open, thereby providing an indication of the condition of the apparatus being controlled.

**Instrument Switches.** Instrument switches are similar to control switches but transfer the connections of the current and potential coil circuits of the various meters to other circuits. They are of the rotary type, with the cams closing silver-to-silver contacts, and are generally used in connection with a common ammeter, voltmeter, and synchroscope switched to different circuits.

## CONTACTOR

A contactor is a device for repeatedly establishing and interrupting an electric power circuit. It is actuated by other than manual means. Relays and contactors are alike in that each is an electric circuit switch actuated by an electromagnet or other power means ordinarily from a remote location.

**Construction.** A relay or contactor usually has a U-shaped magnetic frame of low-magnetic retentivity. A multiturn coil of copper wire is mounted on one leg of the U, and an armature is pivoted on the other leg in a position to extend across the open end of the U. Contacts are mounted on an extension of this armature. When current is made to flow in the coil, the armature is attracted to the frame and its contacts engage mating stationary contacts to establish an electric circuit. When the coil is de-energized, contacts separate as the armature moves away from the frame under the influence of gravity or springs. Mechanically operated contractors employ an armature moved by cams, cranks, or a fluid cylinder.

Relays or contactors have contacts proportioned to the current to be carried, ranging from 1/64 in. diameter, for a few milliamperes, up to compound contacts 2 or 3 in. wide carrying thousands of amperes.

Contact material for relays is usually silver, an alloy of gold, or other precious metal to provide current-capacity and corrosion-resistance as required by the relatively light contact pressures. For contactors, where ample pressure is available, contacts are often of copper, but the use of silver or silver-faced contacts reduces the size. A properly designed silver contact does not require filing or dressing.

A d.-c. relay or contactor has a magnet frame of soft iron or cold-rolled steel. To ensure that residual magnetism does not hold the armature when the coil is de-energized, the magnetic circuit includes a small permanent air gap, often formed by a nonmagnetic "residual" pin or stop that prevents the armature from touching the core of the magnet coil.

An a.-c. contactor has a magnet frame of laminated silicon alloy steel. Such a structure reduces effects due to the cyclic variation of the a.-c. flux, such as heating, and a noisy cyclic pull on the armature. To smooth this pull further, the armature and core face are made to meet accurately, and a lag loop or shading coil that embraces part of the magnetic circuit is provided in one face. This loop establishes a local flux of a time-phase different from the main flux, thereby eliminating periods of zero-pull on the armature.

**Magnetic Starters.** Magnetic starters are industrial control devices for starting and controlling electric motors by use of contactors and relays. A typical starter is a contactor with several contacts or poles, plus a protective overload relay. These poles close or open the motor supply circuit when the contactor is energized by way of a remote control. If excessive motor current flows, the overload relay contacts open the contactor coil circuit, which drops out the contactor to stop the motor.

For larger motors, the starters must limit current while the armature gains speed. For a.-c. motors, several contactors furnish successively increasing percentages of normal voltage to the motor from an autotransformer. For d.-c. motors, the starting current is limited by resistors which are cut out of the circuit by accelerating contactors, successively closed by various schemes.

**Solenoid and Plunger.** Straight line motion of considerable length is produced in many relays and contactors by an electromagnetic solenoid and plunger. The armature plunger moves within the solenoid, which is partially enclosed by an iron frame to form an efficient magnetic circuit. This frame is solid for d.-c. use and laminated for a.-c. Contacts mounted on an extension of the plunger engage fixed contacts and form an efficient, simple device without pivots or hinges.

**Blowout.** The blowout is a magnetic device to assist in breaking the arc formed when contactor contacts are opened. It has a coil with magnetic core and side plates so disposed that a magnetic field is produced in a direction transverse to the arc stream. It is particularly useful in d.-c. circuits where there is no natural "current zero" and an arc between the contacts may persist. Reaction between the blowout field and the magnetic field of the arc forces the arc away from the contacts, eventually breaking it by attenuation. The blowout coil is usually in series with the contactor and, therefore, has a blowout effect proportional to the current being interrupted.

## CIRCUIT BREAKERS

A circuit breaker has been defined as a device for interrupting a circuit between separable contacts under normal or abnormal conditions (A.I.E.E. standards). A movable contact operates under the pressure of a lever or gear mechanism to make or break contact between two stationary terminals mounted on a base. Large breakers are operated by motor or solenoid. The interruption may be accomplished in air or in oil. The responsibility placed upon the breakers is ever increasing because of the constant growth in size of modern power systems, and the absolute dependence on the breakers to open the circuits when necessary to protect apparatus or to maintain continuity of service in the major portions of the power system.

**Air Circuit Breakers.** Air circuit breakers, manually or electrically operated, are available up to 750 volts and in a wide range of ampere capacities, even up into the thousands, and are built for one, two, three, or four poles. By the addi-

tion of appropriate relays that control the tripping of the breaker, protection can be provided against excessive or reverse currents, undervoltage, overvoltage, or unbalanced voltage and phase reversal. Under these controls, the tripping may be arranged as instantaneous or with "inverse time"; in the latter, the heavier the overload current, the faster the breaker will open. Different designs use a variety of elements in association with the final break of the arc so as to avoid roughening or pitting of the main copper contacts, which open first. Thus, in the more common breakers, auxiliary contacts of carbon blocks may take the arcing, but a magnetic blowout is provided for street railway service. They are used to control the circuits for lighting, power and motors, d.-c. and a.-c., and for d.-c. railway circuits for even higher potentials.

**Air-Blast Breaker.** The air-blast breaker has been developed to replace the oil circuit breaker to eliminate the danger of explosion and fire incident to the presence of oil. It uses the prestored energy of compressed air of 135 to 215 lb. per square inch for both breaker operation and circuit interruption, keeping the arcing time practically constant at ½ cycle (1/20 sec.) or less. As the moving contact draws out the arc, an air blast of high velocity, either axial or crosswise, is shot through the arc stream, cooling and quenching the arc at an early current zero.

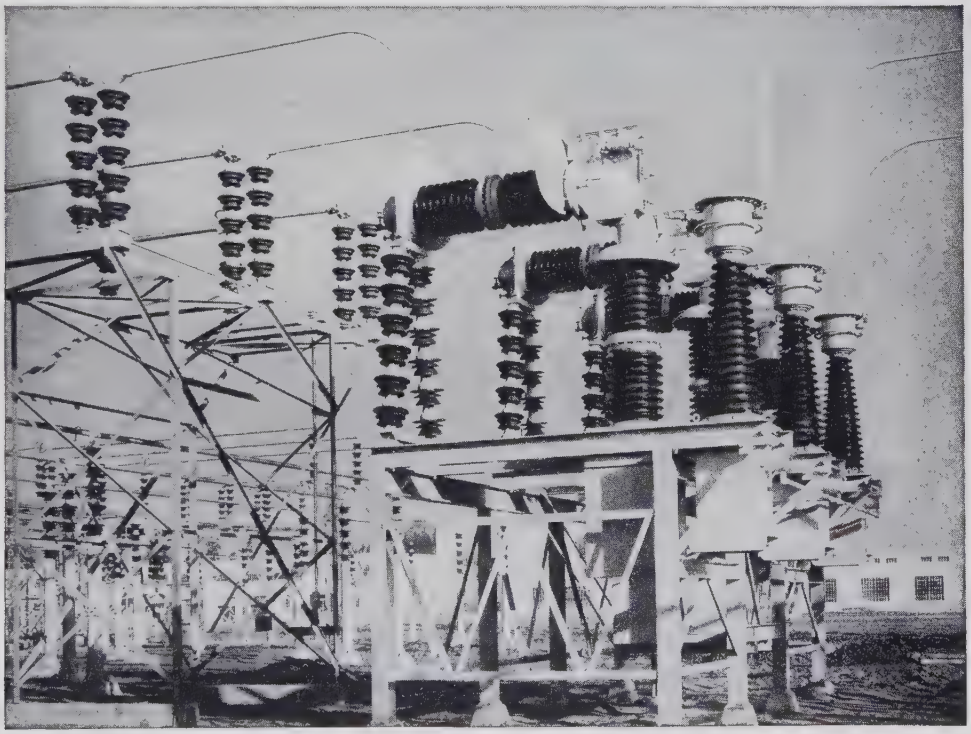
**High-Speed Air Breaker.** The high-speed air breaker is used in industrial service with heavy loads. It is also useful in electric railway service, at 1,200 volts and above, where operating times of from 0.08 to 0.15 sec. are required in order to prevent the flashover of generators or synchronous converters on short circuit. This rapid action is obtained by eliminating the mechanical latch, which holds the ordinary breaker closed, and using instead a magnetic field and an armature on the pivoted lever to hold against a spring tension. The design is such that at excessive current, and with a special bucking bar, the holding field is canceled and the breaker flies open under the pull of the spring. Instead of interrupting the main power flow, the opening of the breaker places a resistor in the circuit and thus limits the machine current to a safe value.

**Deion Circuit Breaker.** The deion circuit breaker is an oilless breaker developed for 15 kv. and 500,000 kv.-a. interrupting capacity in the early application of the multiple cold-cathode principle of Dr. J. Slepian. Later developments have brought forward self-contained air-circuit breakers in successive ratings down to 100,000 kv.-a. at 2.5 and 5 kv. The deion breaker consists of a stack of copper plates each 1/16 in. thick and separated by 1/16 inch from the other. When an arc is drawn between the contacts under the plates, it is blown by a magnetic field into the plates, where it is broken up into a series of arcs each 1/16 in. long. Thus, in every inch of plate structure, each of 8 cathodes has its immediately adjacent, rapidly deionizing gas layer. Instantly after the current passes through zero in its normal cycle, each cathode layer is deionized, rendering it nonconducting. It can withstand 250 volts faster than any practical power circuit can supply it. To reignite the arcs after current zero takes 8 times 250, or 2,000 peak volts per inch of structure.

As a result of research and development to improve interrupting principles, magnetic air breakers are available in which the interrupting capacity in a given space has been more than tripled. The short arc chute, 19 in. long for a 500,000-kv.-a., 15-kv. unit, has made it adaptable to the compact, horizontal drawout construction.

**Oil Circuit Breaker.** The oil circuit breaker long has been standard to open large amounts of a.-c. power and to control high-voltage a.-c. circuits. It can interrupt many more volts per unit length in the oil than in the open air because drops of oil act as deionizing centers in the arc space. These centers consist of relatively cool un-ionized gas, which comes from the decomposition of the oil and mixes turbulently into the arc space. The oil circuit breaker interrupts the a. c. wave at zero value, at which instant the magnetically stored energy of the system is a minimum, an important feature in reducing the surges in connected circuits.

Physically, oil breakers embody the desirable construction



*IMPULSE OIL CIRCUIT BREAKER RATED AT 230,000 VOLTS, 600 AMPERES*

COURTESY OF GENERAL ELECTRIC CO.

features of heavy welded-steel tanks and strong supports for the terminals, necessary to handle the explosive nature of the power interruption. They are available up to 287 kv. with interrupting capacities as great as 3,500,000 kv.-a. High-speed breakers can operate in 3 cycles (1/20 sec.).

The following are typical of the special devices that have been developed to control the arc for heavy power circuits:

*(a)* Addition of oil blast explosion chambers to the stationary contacts of the breaker, where the gas pressure generated by the arc forces oil between the contacts.

*(b)* Use of an increased number of interrupters up to six breaks per terminal for high voltages where the arcs decompose oil into gas which, in turn, creates pressure and forces oil through the ports and between the contacts.

*(c)* Use of the impulse oil circuit breaker for 287 kv., constructed so that each phase has two horizontal herkolite cylinders inside an oil-filled porcelain housing. Eight breaks per phase are employed with compressed springs releasing a force of 24,000 lb. in 0.01 sec. to force oil across each arc path.

*(d)* Addition of deion grids to the contacts, the grid holding the arc in a groove by its magnetic field and forcing it against a solid wall of oil. This arrangement gives a high rate of decomposition of the oil and so supplies continuously fresh un-ionized gas, which is forced through the arc stream to dilute it.

### FUSES

The electric fuse is a protective device housing a metallic link of certain critical dimensions giving it definite current-carrying capacity. When this current is exceeded, the link melts or fuses and thus opens the circuit. Fuses are generally rated on the basis of a room temperature of 75° F.

**Plug.** The household plug fuse with a screw base uses a fusible alloy, ordinarily visible through a mica cover, as its link. This type is limited to 125-volt circuits with 15 amp. on the branch circuits and 30 amp. on the main supply.

**Cartridge.** In cartridge fuses, the link is enclosed within a fiber tube surrounded by a powdered material that excludes air and interrupts the arc when the fuse blows. The ends of the link connect to knife-blade or cylindrical terminals on the cartridge, which make contact when inserted between the mounted clips to complete the circuit. These fuses are rated from 1 to 600 amp. for 250-volt and 600-volt service. In renewable types, a new link can be inserted after one has blown.

**Expulsion.** Expulsion fuses are made to open short circuits on potential and power circuits, both indoor and outdoor. Indoor capacities are as great as 80 amp. and 23 kv.; outdoor capacities, 200 amp. and 115 kv. As the name implies, the fuse is so designed that the expulsion of the metallic vapor extinguishes the arc formed by the blowing of the fuse.

**Oil-immersed.** Oil-immersed fuses enclosed in a strong housing gain the advantage of quenching the arc under oil when the fuse blows. Used as cutouts, they protect primary supply to feeders and branch circuits both in overhead and underground installations. They can handle up to 300 amp. and 15 kv.

### RELAYS

A relay is a device that is operative by a variation in the conditions of one electric circuit to effect the operation of other devices in the same or another electric circuit (A.I.E.E. standards). It is a combination electrical-mechanical device in which a coil, or coils, in an electric circuit will cause a moving element to travel and produce operations, generally in other circuits. Relays, as a class, have an enormous number of functions to perform so that mention of the functions is necessary to specify more particularly the purpose of any specific device.

**Telephone Relays.** Multiple contact telephone relays are an essential element of automatic dialing equipment, some 50,000 being required in a 10,000 line dial exchange. The relays comprise small electromagnets which, when current flows in the exciting coil and magnetizes the core, close twin contacts of palladium, 1/16 in. long, and so pass the current on to the next relay. Thus, in mechanically switching a call through to its destination, relay after relay will close and remain closed until the call is completed. When the subscriber hangs up, the current is interrupted and all relays open by spring action.

**Magnetic Relays.** Magnetic relays, or electromagnets, may be used to open or close automatically the contacts of an electric circuit upon overcurrent or undercurrent in the circuit, or upon overvoltage or undervoltage. In the overcurrent relay, the current flowing through the windings of the coil furnishes the magnetic flux to open the contacts, the pull being balanced against a spring. In the undercurrent relay, the coil is shunt-wound instead of series-wound.

**Protective Relays.** The protective relay is an electrical-mechanical device installed to detect some particular abnormality in the circuit which it guards. When the abnormality appears, the relay causes the appropriate circuit breaker to open and protect the circuit or equipment. It is expected to isolate faulty lines and apparatus automatically from the remainder of the system. The coil, or coils, connected to the circuit are affected by what takes place there and the movable part travels under control of the coil to close a contact device. This last element completes the tripping circuit of one or more breakers.

**High-Speed Relays.** High-speed relays closing in ½ cycle have been developed for use in connection with high-speed circuit breakers working in 3, 5, or 8 cycles. Rapid clearing of the fault prevents burning down the conductors, breaking the insulators, and losing synchronism between the ends of the transmission line.

### SWITCHBOARDS

The switchboard is the control and operating center for the electric power plant. Usually its design is based on the one-line diagram of main connections that shows the generators involved, how many circuits are to be fed, and all special interlocks, relays, and alarm provisions.

For power stations and stations of small capacity, direct current and alternating current up to 2.5 kv., the circuit breakers and bus bars formerly were mounted directly on the board or adjacent to it, so that the switchboard was the actual operating unit. In larger stations, these elements are located at some distance from the board in a bus room or on a switching mat, and the switchboard is the control center.

The switchboard panels for small d.-c. units, one or two machines at 250 volts, generally carry air circuit breakers, manually operated knife switches, a voltmeter with transfer switch, an ammeter, a watt-hour meter, a field ammeter, ground lamps, and a rheostat for each generator. Switches with fuses on subpanels control and protect the feeder circuits.

A. H. L. and R. A. A.

**SWITCH GRASS,** a vigorous perennial, *Panicum virgatum,* having erect stems 3 to 6 ft. tall, growing from creeping rootstocks in dense clumps and bearing long, flat, taper-pointed leaves. The large, spreading, flowering panicle is sometimes 20 in. in length, and the plant is sparingly grown as an ornamental. It is native to the eastern half of the United States and southward to the West Indies; it forms a constituent of prairie hay in parts of the United States.

**SWITHIN, ST.** [swɪ′thɪn] (died 862), counselor of Egbert, king of the West Saxons, and made bishop of Winchester in 852, was famed for humility and charity to the poor. He was patron saint of Winchester Cathedral from 984 until 1538, when his shrine was destroyed and his relics scattered. His feast is July 15, St. Swithin's Day. W. C.

**SWITZERLAND.** The Swiss Confederation is a federal republic composed of twenty-two cantons. The name Swiss Confederation was first used in the Priest's Charter of 1370. The present constitution, formulated and adopted in 1874, legally established the name *La Confédération Suisse*. Switzerland is situated in central Europe between the northern latitudes of 47° 48′ 36″ and 45° 49′ 09″ and the eastern longitudes of 5° 57′ 23″ and 10° 29′ 34″. The total area of the country is 15,940 sq. mi., or just over twice the size of New Jersey. It is bordered on the north by Germany, on the west by France, on the south by Italy, and on the east by Austria and Liechtenstein. Lake Constance and the Rhine River form part of the northern frontier; the Jura Mountains form part of the western boundary; Lake of Geneva and the Italian Alps form part of the southern frontier. The Rhine, turning south from Lake Constance, forms part of the eastern boundary. Three of the Swiss cantons are divided into demicantons, as follows: Appenzell into Appenzell Ausser Rhoden (Appenzell A. Rh.) and Appenzell Inner Rhoden (Appenzell I. Rh.); Basel into Basel-Land and Basel Stadt; and Unterwalden into Nidwalden and Obwalden.

COURTESY OF THE SWISS NATIONAL TOURIST OFFICE

*The Matterhorn, rising 14,705 feet, in the Pennine Alps on the Swiss-Italian border, towers behind a tourist hotel above Zermatt in Valais Canton.*

## GEOGRAPHIC FEATURES

**Topography.** Switzerland is an *El Dorado* for the geologist. The folded Jura Mountains of classical structure, the once-glaciated Swiss Plateau with its moraines, Drumlins, and eskers, and above all the geologically complex Alps, with their sheetfolding structure, give a variety nowhere equalled in such a small area. Switzerland can be divided easily into three natural regions: the Jura Mountains, the Swiss Plateau, and the Alps. The Jura form the boundary zone between Switzerland and France, extending from Geneva (Genève) to Basel and Schaffhausen. They consist of regular limestone folds, similar to those of the Appalachians, and result in longitudinal valleys, long-stretched ranges, and narrow gaps giving outlet for the rivers through the ranges. Only the valleys can be used for cultivation; the ranges themselves are forest covered or have pastures. The density of population is low. The Swiss Plateau is actually a basin between the Jura and the Alps, filled with glacial material dating from the Ice Age and now eroded by the many rivers. Its surface is rolling, with broad cultivated valleys and wooded divides. Here live the bulk of the Swiss population; here are the real crop fields and pastures and the larger cities; here also is the industrial development for which Switzerland is so well known. The Alps comprise roughly the southern half of Switzerland. High, snow-covered mountain massifs are separated by deeply eroded valleys. In the chief valleys the broad river bottoms are used for cultivation. The slopes leading up to the Alpine meadows are forested. The population is sparse, but the Alps are a major source of income because of the beauty of their scenery and the attraction of the high mountains for the mountaineers. Tourists flock to them in summer and in winter. Resorts are found everywhere.

*Rivers and Lakes.* Most of Switzerland belongs to the Rhine system, especially to the Aare, a tributary of the Rhine which combines the many rivers of the Swiss Plateau, such as the Reuss and the Limmat. Outside of the Rhine drainage system are the Rhône in the southwest; the Ticino, a tributary of the Po, in the south; and the Inn, a tributary of the Danube, in the east. None of the latter rivers has any value to the Swiss from the point of view of transportation. The Rhine becomes navigable at Basel, just inside the Swiss boundary. Switzerland is famous for its lakes, and practically all of them are of glacial origin, dating from the time when large glaciers poured out of the mountains, invading the surrounding territory. The largest lakes are scattered across the country from southwest to northeast: Lake of Geneva, Lake of Neuchâtel, Lake of Bienne, Lake of Thun, Lake of Brienz, Lake of Luzern, Lake of Zug, Lake of Zürich, Lake Wallen and Lake Constance. In the south, in Ticino Canton, are Lake Lugano and Lake Maggiore. The beauty of these lakes, with their vivid color and mountain setting, has been a great asset to the Swiss tourist industry.

**Climate.** Mountainous Switzerland has marked climatic variations, influenced both by the altitude of the different regions and by their exposure to the prevailing winds and the sun. Temperatures in the lower valleys average between 50° and 60° F. annually, but in summer they rise to 86° or more. July is the hottest month, January the coldest.

In the Alps, perpetual snow covers the highest peaks, the snow line ranging from about 9,000 ft. on the western heights to 10,500 ft. on the eastern mountains. Winter temperatures are below freezing throughout the country except for the north shore of the Lake of Geneva and of the Swiss-Italian lakes, areas protected from the cold north wind, known as the *bise,* and having a mild climate like that of northern Italy. During January and February high-pressure conditions over the Alps bring the clear, cold weather best suited to winter sports, for which Switzerland is noted. The southern

*THE AARE RIVER AT BERN, SWITZERLAND*

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slopes benefit from the direct rays of the sun and are much warmer than the northward-facing slopes.

Sudden violent storms, with rain or snow, are numerous in Switzerland. In the spring, summer, and fall, the prevailing wind is the *föhn,* a warm, dry wind blowing from the east and southeast. Because the moisture-laden winds from the Mediterranean encounter the barrier of the Alpine ranges, the southward-facing slopes receive nearly twice as much rainfall as those facing north. Most of the winter precipitation is in the form of snow, the accumulation in the valleys averaging from 20 to 25 ft. in depth and in the high mountains from 45 ft. upwards. The average annual precipitation at Basel (910 ft.) is 32.5 in.; at Lausanne (1,220 ft.), 46.3 in.; and at Bevers (5,620 ft.), near St. Moritz, 32.5 in.

**Soils.** Soils are generally leached and poor. They are stony on the mountain slopes, but fertilizers are used on the better ground to make higher production possible. Three-fourths of the Swiss area is productive, about one-third of which is forest and the rest crop land and pasture.

**Flora and Fauna.** The flora varies according to climate and altitude. The Swiss Plateau is still part of the central European oak and beech zone, although those trees are often intermixed with pines. On the south slope of the Alps the chestnut is the most typical tree. High on the slopes conifers prevail more and more, forming a transition zone between the deciduous trees and the Alpine meadows on high elevations. Characteristic of the mountains are the very colorful flowers, starting with the crocus and narcissus in the spring and culminating with a profusion of types, among which are the Alpine roses, the saxifrages, the various gentians, and the rare edelweiss. Wild animal life has been greatly reduced by man; while the Alpine partridge and the mountain hare abound, the deer, the marmot, and the chamois, which inhabit the higher Alpine regions, are less common. Much is being done to preserve remnants of former fauna. In the Swiss National Park, near the Austrian border, there are, in addition to deer and chamois, still a few ibex and foxes, as well as white snow grouse and eagles. S. VanV.

## ETHNOLOGY AND POPULATION

**Racial Origins.** The racial origins of most of the population are Roman and German. The country was occupied successively by the Helvetians, Romans, Alamanni, Burgundians, and Franks. Racially the Swiss approach the Alpine type; they are rather short and stocky, with brown hair and dark or grayish eyes. However, there has been a strong influx of the fair Nordic type. While the Swiss are a unit nationally, there are four different ethnographic groups: the German Swiss, the French Swiss, the Italian Swiss, and the Rhaeto-Roman Swiss. Each speaks its own language. There is also a large foreign element in Switzerland; some foreigners have been attracted by the peace and beauty of the country, while others are political refugees. The foreign population varies, but generally totals about 400,000.

**Language.** On the basis of spoken language the population was distributed in 1941 as follows: German 3,097,060; French, 884,669; Italian, 220,530; Romansh (a Rhaeto-Romanic dialect of Indo-European derivation, spoken in Grau-

bünden), 46,456; others, 16,990. The five French-speaking cantons (Fribourg, Vaud, Valais, Neuchâtel, Geneva) are in the western part of the country along the French border. Ticino, the lone Italian-speaking canton, is on the Italian border. In the remaining cantons German is the dominant language.

**Religion.** The Protestants form a majority in the country, although there are many Roman Catholics. In 1941 the communicants of the various faiths numbered as follows: Protestants, 2,457,242; Catholics, 1,724,205; Jews, 19,429; others, 34,828. Of the five French-speaking cantons, Valais and Fribourg are the only ones in which Catholics outnumber Protestants. Ticino, the Italian-speaking canton, is overwhelmingly Catholic. Romansh-speaking Graubünden is almost evenly divided. The strongest Protestant cantons are Zürich, Bern, Glarus, Basel, Appenzell A. Rh., Schaffhausen, Thurgau, Vaud, and Neuchâtel. The strongest Catholic cantons are Luzern, Uri, Schwyz, Unterwalden, Zug, Fribourg, Appenzell I. Rh., Ticino, and Valais. Most of the Jews live in Basel, Zürich, and Geneva.

**Occupations.** In 1941 the cities of 10,000 inhabitants or over contained a total of 1,402,335 individuals, while cities of under 10,000 inhabitants, plus the definitely rural population, totaled 2,863,368 individuals. By this standard, most of the Swiss live in the country or the small towns. It does not mean, however, that most of the population is engaged in agricultural pursuits, since industry in Switzerland is quite decentralized. According to the Swiss Federal Bureau of Statistics, of every 1,000 Swiss inhabitants earning a livelihood in 1941, 208 worked in agriculture and forestry, 435 worked in industry, and 100 worked in commerce, banking, and insurance. In only three cantons, Fribourg, Graubünden, and Valais, and two demicantons, Obwalden and Appenzell I. Rh., did the number engaged in agriculture exceed the number engaged in industry. By this same standard the most industrialized cantons were Zürich, Uri, Glarus, Zug, Solothurn, Basel (both Land and Stadt), Schaffhausen, St. Gallen, Aargau, Thurgau, and Neuchâtel. In the demicanton of Appenzell A. Rh., 489 per 1,000 inhabitants were engaged in industry.

**Population.** Official statistics placed the population of Switzerland in 1941 at 4,265,703; the official estimate for 1946 gave 4,506,000. According to the latter date, the five largest cities are: Zürich, 366,752; Basel, 172,837; Bern, the capital, 137,816; Geneva, 139,735; and Lausanne, 99,372.

## GOVERNMENT AND POLITICS

**Central Government.** The Constitution of 1874, plus numerous amendments up to September 1950, form the basis of the present government. The government is a federal republic with sovereignty residing in the people and in the various cantons. The powers of the federal government are exercised through a two-chamber legislature, an executive council responsible to the legislature, and a federal tribunal. The legislature (Federal Assembly) is composed of the National Council, elected on the basis of population (roughly one representative for every 22,000 citizens), and the Council of States, which represents the cantons (two representatives for each canton, or forty-four in all). Universal suffrage prevails in the choosing of the electoral colleges in the cantons, which in turn choose the members of the National Council. The principle of proportional representation operates in the distribution of seats to the parties by these electoral colleges. The members of the Council of States are chosen by the diets of the respective cantons. The executive power resides in the Federal Council, which is composed of seven members chosen by the Federal Assembly from all citizens eligible to the National Council. The Federal Council is responsible to the Federal Assembly, and because of this the Swiss government is essentially more akin to the British form of government than it is to the American form, to which it bears a similarity in the matter of federalism. The Federal Tribunal is selected, like the Federal Council, by the Federal Assembly; it exercises not only the usual

*The fourteenth-century Kapellbrücke, one of Luzern's picturesque covered bridges, and the octagonal water tower add to Luzern's fame as a tourist center.*

FRANZ SCHNEIDER

PHILIP GENDREAU

*A workroom in one of the watch factories that have made Geneva world-famous as a clock- and watch-making center*

trial powers of such a court but also wide interpretative powers, defining the powers of the federal government, arbitrating between the cantons, and safeguarding the residual powers of both the people and the cantons from encroachment by the federal government. The policies of the government are subject to ultimate review by the people through the initiative and referendum, possibly the best-known contributions of the Swiss to the advancement of popular government.

*Federal Powers.* By the Constitution of 1874 the government of the confederation was given considerable powers, such as sole power to declare war and make peace and to conclude treaties of alliances; the power to train, equip, and direct the military forces and even recruit forces directly in time of emergency; and the power to levy import taxes and to regulate the foreign trade. The federal government has complete control over forests, fish and game, railroads, money, weights and measures, marriage and divorce, posts and telegraph, higher education, and hours and conditions of labor. It also has the right to legislate for the control of communicable diseases and in certain categories of commercial, civil, and penal law. The federal government also undertakes to guarantee civil liberties to all Swiss citizens. The amendments to the constitution since 1874 have given the federal government power over all hydraulic resources, air navigation, manufacture of armaments, essential highways, and other matters of federal concern.

**Political Parties.** General elections are held in Switzerland every four years. In the elections of 1947 the preponderance of center and right parties was continued. Representation in the National Council was as follows: Radicals (a liberal party), 52 seats; Social Democrats, 48; Catholic Conservatives, 44; Peasant Party, 21; Landesring and Liberal Socialist Party, 9; Liberals, 7; Communists, 7; Democrats, 5; and independents, 1. For the Council of States the representation was: Catholic Conservatives, 18; Radicals, 11; Socialists, 5; Peasant Party, 4; Liberals, 2; Democrats, 2; and independents, 2.

**Finance.** During World War II the budget showed a deficit of about one billion francs each year, but in 1946 the tide turned and in 1947 receipts totaled 2,154,430,000 francs and disbursements 1,933,461,000. The total debt of Switzerland at the end of 1948 was nearly eight billion francs.

**Armed Forces.** Military service in the national militia is compulsory and universal, with varying periods of service required after initial training. Fully mobilized, Switzerland's armed forces total 720,000, including 270,000 men and women in the auxiliary services. Much of the defense of the country has been based on fortifications guarding the key mountain passes. In 1949 there was an air force of 25 squadrons and 500 fighter planes.

## ECONOMIC ACTIVITIES

**Industry.** Switzerland is a highly industrialized country. Before World War II the production of textiles, machines, watches, watch parts, jewelry, wood products, foodstuffs, and tobacco, along with the construction industry, absorbed most of the industrial energy of the people. Also important are the paper, leather, rubber, graphic art, and chemical industries. World War II dislocated Swiss industry; the chemical, metal, and machine industries were greatly expanded at the expense of certain textile industries. Since the war these industries have been reverting to their prewar ratios. The increased use of machinery and electric power has contributed toward decentralization of industry, which fits well the over-all economic picture of the country and particularly its agricultural pattern, which is characterized by small farms specializing in products for local consumption. The Swiss export large quantities of heavy machinery, such as turbines, locomotives, and diesel engines. They are widely known for their production of machine tools and precision instruments. They produce, in addition, a variety of military supplies and equipment.

**Commerce.** Switzerland has a highly developed foreign trade. Since it was surrounded by the Axis armies in World War II, there was naturally a precipitate decline of British, French, and American trade with Switzerland and a great increase of German and Italian trade. Trade also increased with the Axis satellites, as well as with such neutrals as Sweden, Spain, and Argentina. Since World War II the Swiss have continued to maintain sizable trade relations with the Balkan and central European countries. There have been indications that the U.S.S.R. is anxious to improve its trade relations with Switzerland. At the end of World War II the Swiss imports and exports were far below their normal prewar level. Since then Switzerland has concluded important trade agreements. In general, with expansion of trade since the war, there has been an excess of imports over exports; imports totaled 4,998,900,000 francs in 1948, and exports 3,434,500,000. Nearly one-third of the imports came from the United States, followed by France, the United Kingdom, Italy, Argentina, Germany, and Sweden; the United States took the greatest share of Swiss exports, and France, Sweden, Italy, Argentina, and the United Kingdom, in that order, a smaller share.

**Agriculture.** The agricultural resources of the country do not allow for complete self-sufficiency. Wheat and cereals must be imported. However, some fruit and dairy products are available for export. In 1945 the cantons with the greatest amount of land under cultivation ranked in the following order: Bern, Vaud, Zürich, Fribourg, Aargau. Those with the least land under cultivation were Uri, Glarus, Unter-

walden, and Appenzell. The total of hectares under cultivation (one hectare equaling 2.47 acres) has increased from 191,668 in 1917 to 335,292 in 1945. Most sheep and goats are produced in the canton of Graubünden. The cantons which led in the production of cattle were Bern, Zürich, Luzern, Fribourg, St. Gallen, and Vaud. The timber industry is sufficient to meet the local needs.

*A shepherd bringing home his flock passes an old château in the Tarasp-Schuls-Vulpera region of the lower Engadine, one of the most picturesque regions of Switzerland.*

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**Mining.** Despite its mountainous terrain, Switzerland is not rich in minerals, and hence mining is not too prominent in the economy. Salt is mined in two districts, Bex and the area of Schweizerhalle, Rheinfelden, and Ryburg. The cantons in both cases hold a monopoly. However, at Bex the canton of Vaud has leased the mines to a private company, while in the other district the cantons themselves work the mines through a joint stock company. The two chief iron mines in the country are the Fricktal Mines in the canton of Aargau and the Gonzen Mines, near Sargans. In 1937 Switzerland exported 148,580 tons of iron ore, 17,180 tons of copper, and 27,310 metric tons of aluminum and aluminum products. In recent years extensive geological surveys have been made to ascertain the oil resources of the country. As a result, a small quantity of oil is now being produced by a few wells in the canton of Vaud.

**Transportation and Communications.** The Swiss have a well-developed system of railroads. In 1947 the total length, normal and narrow gauge, was 3,245 mi., of which 1,708 mi. were electrified. All the main trunk lines are owned and operated by the federal government. The system connects all principal cities. Motorized transport and airlines supplement the railways. There were in 1950 some 10,000 mi. of good highways. There is considerable transport by water, especially on the Rhine River. Basel has developed into one of the major inland ports in Europe. The government owns and operates all telephone and telegraph lines and Radio Suisse.

**Money and Banking.** Economic and political stability has enabled Switzerland to develop one of the most advanced banking systems in the world, far disproportionate to the country's size. Foreign funds have flown in a steady stream into Switzerland, seeking safety in a war-torn and politically unstable world. The banking system can be divided into the state system and the private system, although the tendency has been for the state system to absorb the private. The state system centers around the Swiss National Bank and the cantonal banks. The Swiss National Bank started operations June 20, 1907. It has the exclusive right to issue paper money, and is a stock company in which the cantons hold shares but the federal government does not; however, the latter has power to control the bank. It establishes the amount of metallic reserve that the bank must

*The entrance to the Simplon railway tunnel, 12¼ miles long, at Brig*

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maintain and may change the reserve ratio when it so desires. It performs the usual central bank services for the government. The cantonal banks supplement the functions of the central bank. The private banking system centers around a few great commercial banks, which in 1926 were eight in number and were members of the Cartel des Banques Suisses. At that time their paid-in capital stock was one-fourth that of all the banks. The country's monetary unit is the Swiss franc, worth about 23½ cents in United States money.

**Labor.** The chief trade union federation in Switzerland is the Union Syndicale Suisse. Its total membership was 312,935 in 1945. It contained most organized workers, but there are a number of other labor organizations, some of them with marked religious leanings. More akin to the Union Syndicale Suisse, in that the federative principle is employed, is the Federative Union of Personnel of Administrations and Public Enterprises, which is composed of unions of workers in various branches of the federal government, especially the munitions industries, the postal services, the railways, and the central administrative offices. Some of the member unions of this federative organization are also attached to the Union Syndicale Suisse, such as the railroad, public service, telephone and telegraph, munitions, and postal workers. The membership of the Federative Union of Personnel of Administrations and Public Enterprises was 84,541 in 1945. The Federation of Swiss Societies of Employees is the third large federative organization. In 1945 it was composed of seven unions, of which workers in retail establishments formed the largest union, and had a total membership of 71,983. The various cantons have conciliation committees to settle trade disputes. In 1945, out of 354 cases submitted to these boards, 313 were settled.

## SOCIAL AND CULTURAL ACTIVITIES

**Cultural Development.** Switzerland has a rich cultural heritage. It has produced many outstanding men of art, literature, and science. Both Nikolaus Manuel (1484-1530) and Hans Holbein the Younger (c.1497-1543), the gifted Renaissance artists, were Swiss, and so was the physician Paracelsus (c.1493-1541), sometimes considered the first modern scientist. Nicholas of Flüe (1417-1487), a theologian, achieved wide recognition and was canonized in recent years. Huldreich Zwingli (1484-1531) and John Calvin (1509-1564), great religious reformers, are claimed by the Swiss. Swiss artists of repute include Heinrich Füssli (1742-1825) and Ferdinand Hodler (1853-1918).

*Literature.* Though small in size, Switzerland has a great literary tradition. Johann Bodmer (1698-1783) and Johann Breitinger (1701-1776) exerted influence on German literature. Mme. de Staël (1766-1817) was of Swiss parentage. The Swiss are also proud of their outstanding educator, Heinrich Pestalozzi (1746-1827). Other well-known Swiss writers are Jeremias Gotthelf, Gottfried Keller, Conrad Ferdinand Meyer, Rodolphe Töpffer, and Carl Spitteler. Among contemporary writers Hermann Hesse, novelist, Karl Barth, Protestant theologian, and the novelist C. F. Ramuz are probably best known. The people of Ticino have produced a somewhat provincial literature. Their outstanding present-day writer is Francesco Chiesa. Among the Romansh, Peider Lansel is the foremost poet. Two Swiss historical writers are outstanding: Jakob Burckhard, author of a classical history of the Renaissance, and Johannes von Müller, author of *The History of the Swiss Federation.*

**Education.** Education is compulsory, though the age limit is set variously by the cantons. Generally speaking, however, primary and a certain amount of secondary education is required of all Swiss youth. Education in the primary and secondary levels is free. In 1947 the total enrolled in the primary schools was 433,332. Teachers numbered 13,692. All secondary schools for the same period showed an enrollment of 75,546 with 3,043 teachers. There are seven universities: Basel, Zürich, Bern, Geneva, Lausanne, Fribourg, and Neuchâtel. In addition to these, a great number of technical schools offer specialized training in the crafts and professions. The Federal Polytechnic School attracts students from all over Europe. The Commercial University at St. Gallen is also well known. The last two schools, though ostensibly offering university work, are considered technical schools.

## HISTORY

**Founding of the Swiss Confederation.** The Helvetians, the first recorded inhabitants of the region now known as Switzerland, were subjugated by the Romans under Julius Caesar. When the Roman Empire went into decline in the fifth century, the territory was occupied by the Alamanni, Franks, and Burgundians. During the period of Charlemagne the Franks extended their control over the entire area, ruling through the duke of Swabia. When the Carolingian empire disintegrated in the ninth century, the Swabian dukes came forward and took over the government of the region, but they were unable to maintain their control because of the era's feudalistic tendencies. As the thirteenth century opened the territory presented an array of feudal principalities. The counts of the House of Hapsburg exercised suzerainty over a number of these and at this time began to expand their feudal claims in the remaining number. Fearing that the growing power of the Hapsburgs would circumscribe the liberties that they enjoyed under their local lords, the cantons of Uri, Schwyz (from which the name of Switzerland comes), and Unterwalden appealed to Frederick II, ruler of the Holy Roman Empire.

*Charter of 1231.* In response to their plea, Frederick issued a charter in 1231 granting them exemption from the authority of the local feudal lords and bringing them under the direct authority of the emperor. With the death of Frederick II in 1250 the imperial power entered a period of rapid decline, marked initially by a civil war in which two factions contended for the throne and during which the empire was without a head (the Great Interregnum). The disturbed condition of the empire allowed the three Swiss cantons to develop their own political institutions, but at the same time it gave the Hapsburg counts an opportunity to extend their control in the region.

*Defeat of the Hapsburgs.* However, the counts were busy with the conquest of Austria and delayed sending forces against the cantons. The cantons used this time to mature their separate governments and form a defensive league in 1291. When the Hapsburgs finally moved against the cantons in 1315, the forces of the league inflicted a smashing defeat at the Battle of Morgarten. After this triumph the league proceeded to enlarge itself between 1315 and 1353 by admitting to membership the cantons of Luzern, Zürich, Glarus, Zug, and Bern. By winning the battles of Sempach and Näfels, the eight cantons achieved real independence; the Hapsburgs in the treaty of 1389 renounced all feudal claims on the cantons. Thereafter the only authority with which the cantons had to reckon was that of the emperor, and that became increasingly ineffective as the empire declined.

**Rise to Power.** After the peace of 1389 the Swiss League or Confederation (*Eidgenossenschaft*), as it was called in the Priest's Charter of 1370, proceeded to follow the pattern of

# SWITZERLAND

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## SWITZERLAND

Area.....15,940 sq. m.
Population....4,904,000

KEY TO MAP SYMBOLS

- National Capital
- Size of symbols and type indicates relative population.

CITIES AND TOWNS


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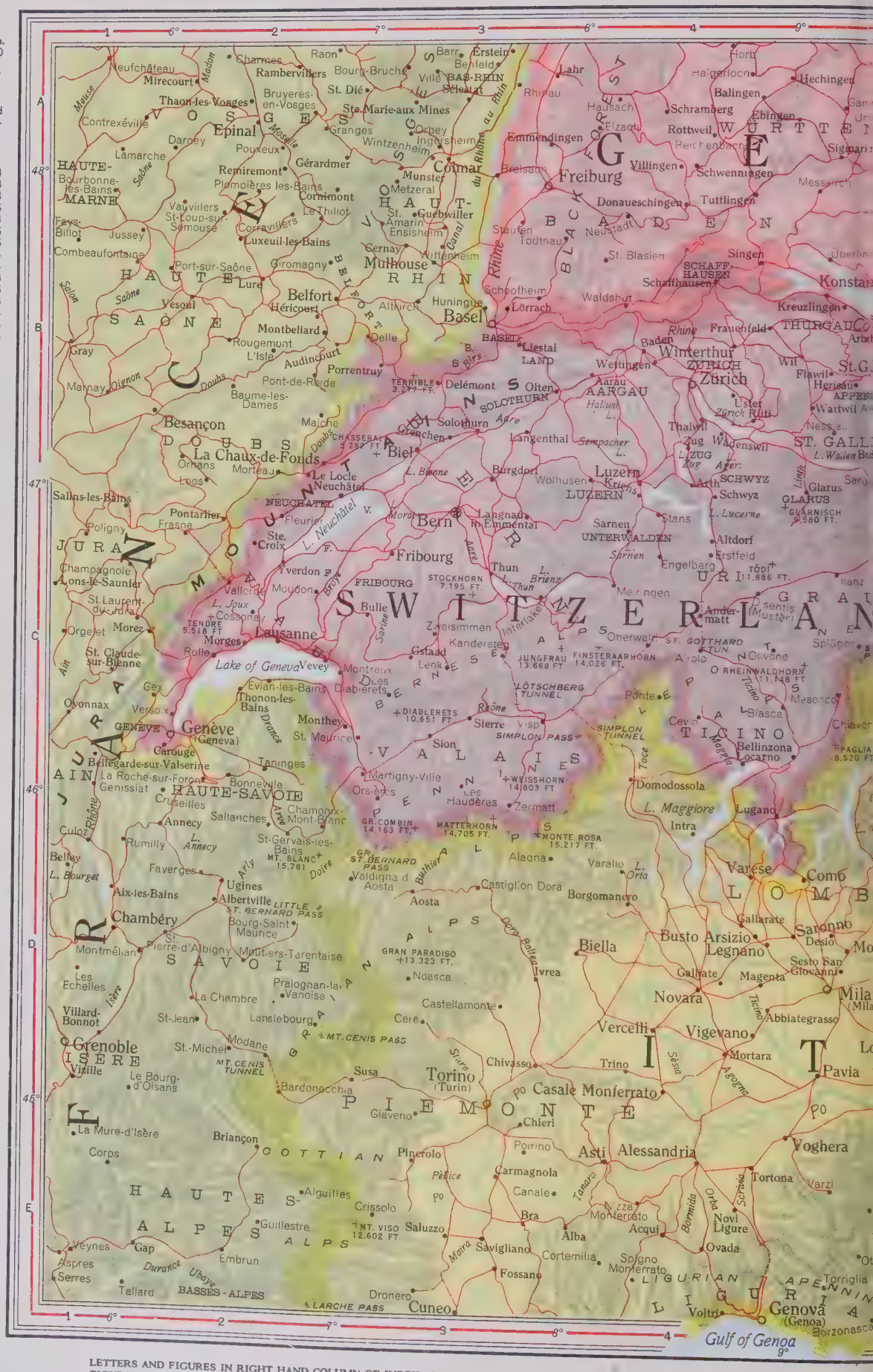
SWITZERLAND
Lake of Geneva
Gulf of Genoa
Genève (Geneva)
Basel
Bern
Zürich
Luzern
Lausanne
Fribourg
Neuchâtel
Biel
Solothurn
Thun
Interlaken
Montreux
Vevey
Sion
Martigny-Ville
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Schwyz
Arth
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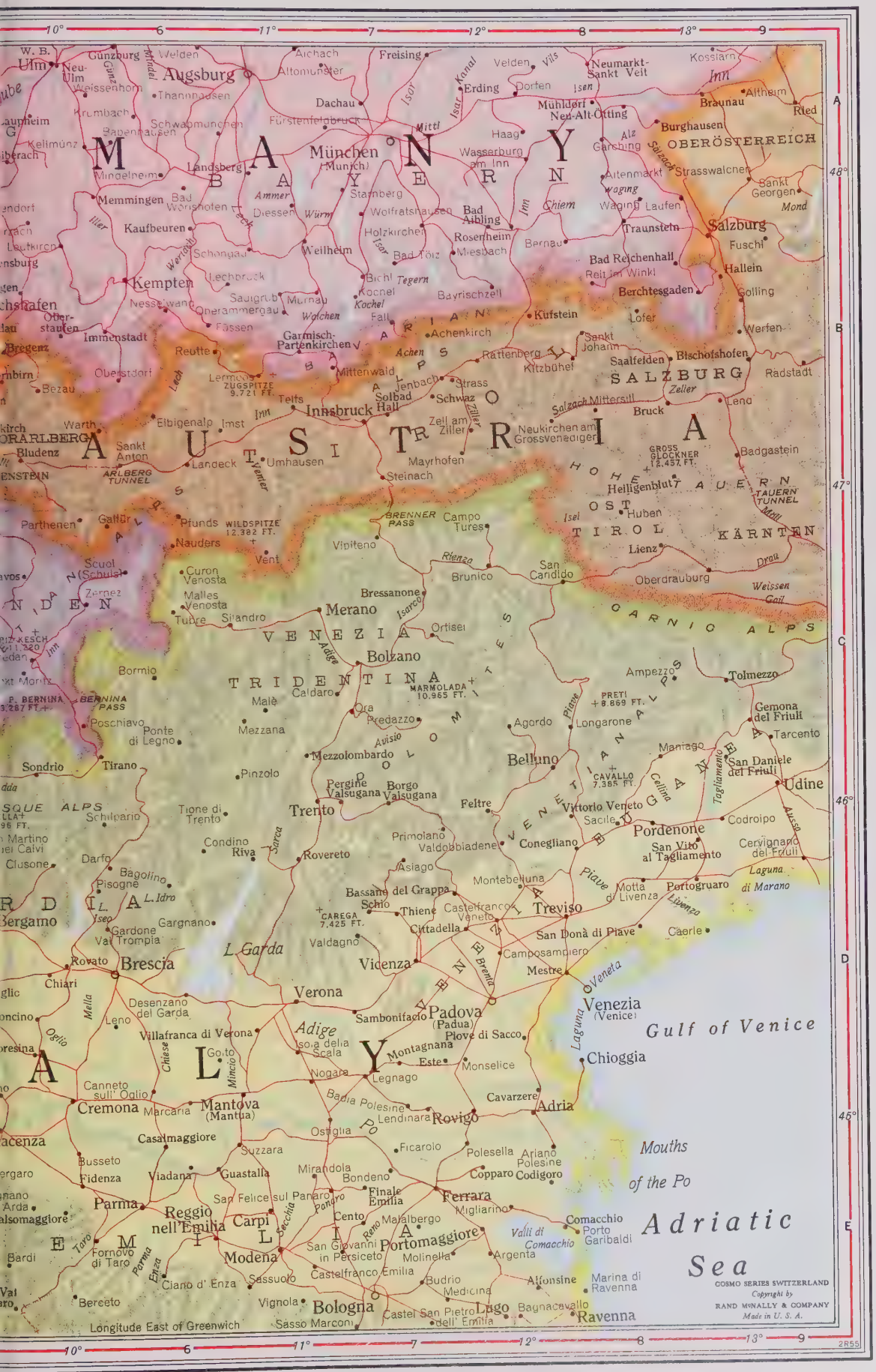
Wädenswil
Zug
Rapperswil
Wattwil
Herisau
Appenzell
Flawil
Uzwil
Wil
Frauenfeld
Kreuzlingen
Konstanz
Schaffhausen
Singen
Waldshut
Lörrach
Basel
Liestal
Baden
Brugg
Aarau
Olten
Langenthal
Burgdorf
Wolhusen
Sempach
Wettingen
Zurich
Winterthur
Uster
Rüti
Thalwil
Horgen
Rapperswil
Wädenswil
Ziegelbrücke
Sargans
Buchs
Chur
Ilanz
Disentis
Andermatt
Hospental
Realp
Oberwald
Brig
Visp
Sierre
Sion
Martigny
Orsières
Aosta
Ivrea
Biella
Novara
Vercelli
Casale Monferrato
Alessandria
Asti
Voghera
Tortona
Pavia
Milan
Como
Varese
Lugano
Locarno
Bellinzona
Chiasso
Domodossola
Stresa
Arona
Intra
Verbania
Gallarate
Busto Arsizio
Legnano
Saronno
Sesto San Giovanni
Magenta
Abbiategrasso
Mortara
Vigevano
Chivasso
Torino (Turin)
Susa
Bardonecchia
Modane
Briançon
Grenoble
Chambéry
Annecy
Aix-les-Bains
Albertville
Bourg-Saint-Maurice
Moûtiers-Tarentaise
Pralognan-la-Vanoise
La Chambre
Lanslebourg
St-Jean
St-Michel
La Mure-d'Isère
Corps
Gap
Embrun
Guillestre
Alguilles
Crissolo
Saluzzo
Cuneo
Dronero
Fossano
Savigliano
Cortemilia
Alba
Bra
Acqui
Ovada
Novi Ligure
Tortona
Voltri
Genova (Genoa)
Torriglia
Borzonasca
Chiavari
Sestri Levante
Rapallo
Portofino
Varazze
Savona
Albenga
Ventimiglia
Nice
Menton
Monaco
Monte Carlo
Cannes
Grasse
Antibes
Draguignan
Toulon
Marseille
Aubagne
Brignoles
Digne
Barcelonnette
Briançon
Gap
Embrun
Guillestre
Serres
Tallard
Veynes
Aspres
Durance
Ubaye
Col du Grand St. Bernard
Col du Mont Cenis
Col de Larche
Col du Simplon
Col du Nufenen
Col de la Furka
Col de la Forclaz
Col de la Faucille
Col de la Croix de Fer
Col du Galibier
Col de Vars
Col de Tende
Col de Restefond
Col de la Bonette
Col de la Cayolle
Col de Allos
Col de Vizzavona
Col de Bavella
Col de Sorba
Col de Verde
Col de Teghime
Col de Bocognano
Col de Vergio
Col de Lavezzo
Col de Tenda
Col de Sospel
Col de Braus
Col de Turini
Col de la Madone
Col de la Colmiane

# SWITZERLAND




Vallorbe, 3,896 . . . . . C 2
Versoix, 2,471 . . . . . C 2
Vevey, 14,500 . . . . . C 2
Visp, 2,727 . . . . . C 3
Wädenswil, 10,300 . . . . . B 4
Wattwil, 6,336 . . . . . B 5
Wettingen, 13,200 . . . . . B 4
Wil, 8,681 . . . . . B 5
Winterthur, 69,400 . . . . . B 4
Wolhusen, 3,255 . . . . . B 4
Yverdon, 13,500 . . . . . C 2
Zermatt, 1,395 . . . . . C 3
Zernez, 739 . . . . . C 6
Zug (Zoug), 15,700 . . . . . B 4
Zürich (Zurich), 409,300 . B 4
Zweisimmen, 2,599 . . . . . C 3

## CANTONS

AARGAU . . . . . B 4
Area . . . . . 542 sq. m.
Pop . . . . . 313,500

APPENZELL (Ausser-Rhoden) B 5
Area . . . . . 94 sq. m.
Pop . . . . . 48,500

APPENZELL (Inner-Rhoden) B 5
Area . . . . . 67 sq. m.
Pop . . . . . 13,300

BASEL-LAND . . . . . B 3
Area . . . . . 165 sq. m.
Pop . . . . . 115,500

BASEL-STADT (BASEL) . . B 3
Area . . . . . 14 sq. m.
Pop . . . . . 205,300

BERN (BERNE) . . . . . C 3
Area . . . . . 2,658 sq. m.
Pop . . . . . 831,300

FRIBOURG . . . . . C 3
Area . . . . . 645 sq. m.
Pop . . . . . 161,800

GENÈVE (GENF) . . . . . C 2
Area . . . . . 109 sq. m.
Pop . . . . . 213,300

GLARUS (GLARIS) . . . . . B 5
Area . . . . . 264 sq. m.
Pop . . . . . 38,600

GRAUBÜNDEN . . . . . C 5
Area . . . . . 2,746 sq. m.
Pop . . . . . 141,200

LUZERN (LUCERNE) . . . . B 4
Area . . . . . 576 sq. m.
Pop . . . . . 233,800

NEUCHÂTEL . . . . . C 2
Area . . . . . 309 sq. m.
Pop . . . . . 134,400

ST. GALLEN . . . . . B 5
Area . . . . . 777 sq. m.
Pop . . . . . 318,200

SCHAFFHAUSEN . . . . . B 4
Area . . . . . 115 sq. m.
Pop . . . . . 58,500

SCHWYZ . . . . . B 4
Area . . . . . 351 sq. m.
Pop . . . . . 72,700

SOLOTHURN . . . . . B 3
Area . . . . . 306 sq. m.
Pop . . . . . 178,600

THURGAU . . . . . B 4
Area . . . . . 388 sq. m.
Pop . . . . . 154,300

TICINO (TESSIN) . . . . . C 5
Area . . . . . 1,086 sq. m.
Pop . . . . . 178,600

UNTERWALDEN (Nidwalden) . . . . . C 4
Area . . . . . 106 sq. m.
Pop . . . . . 19,800

UNTERWALDEN (Obwalden) . . . . . C 4
Area . . . . . 190 sq. m.
Pop . . . . . 22,500

URI . . . . . C 4
Area . . . . . 415 sq. m.
Pop . . . . . 29,300

VALAIS (WALLIS) . . . . . C 3
Area . . . . . 2,021 sq. m.
Pop . . . . . 163,000

VAUD (WAADT) . . . . . C 2
Area . . . . . 1,239 sq. m.
Pop . . . . . 388,200

ZUG (ZOUG) . . . . . B 4
Area . . . . . 93 sq. m.
Pop . . . . . 44,800

ZÜRICH (ZURICH) . . . . B 4
Area . . . . . 668 sq. m.
Pop . . . . . 824,000

## LIECHTENSTEIN

**Area . . . . . 65 sq. m.**
**Population . . . . . 11,218**

CITIES AND TOWNS

Vaduz, 2,772 . . . . . B 5

COSMO SERIES SWITZERLAND
Copyright by
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Made in U. S. A.

Statute Miles 5 0 5 10 20 30 40 50
Kilometers 5 0 5 10 20 30 40 50 60

Lambert Conformal Conic Projection
SCALE 1:2,000,000 1 Inch = 32 Statute Miles

development so clearly outlined by the events of the fourteenth century. New cantons were admitted, and by 1513 the confederation consisted of thirteen members. The cantons perfected their alliance so that it assumed more of the aspects of a federal union, although regular meetings of a constitutionally established diet were not yet inaugurated. In the fifteenth and sixteenth centuries the confederation began to play a role as a European power, fighting wars with Charles of Burgundy, concluding alliances with Louis XI of France, and even holding a feeble and tentative balance of power in the Italian wars of the French kings with the Hapsburgs. The Reformation saw Zwingli leading Zürich, and Calvin dominating Geneva, while the southern cantons remained within the Catholic fold. But the confederation was disrupted only temporarily by these religious differences; the menace of the outside powers promoted unity in spite of such profound differences and gave added substance to the federal principle. The Peace of Westphalia in 1648 marked the recognition of Swiss independence by all the European states.

AERIAL VIEW OF THE CITY OF GENEVA, SWITZERLAND

J. GABERELL

**The Helvetic Republic.** The French Revolution had a profound effect on the Swiss cantons. In 1797 the French armies, to counter a similar military move by Austria, invaded the cantons and by the spring of the following year had completed the conquest of the comparatively weak cantons. The French established the Helvetic Republic in place of the loose arrangement of the Swiss Confederation. The Constitution of 1798 established for the first time in Swiss history a strong central government. The government exercised control over money, trade, justice, police, and even the army. The French administrative system was adopted, and the central government was empowered to appoint prefects and subprefects to the cantons and districts. These powers were exercised by the central government through a bicameral legislature, a supreme court, and a directory which was ostensibly responsible to the legislature. Such basic doctrines as the ultimate sovereignty of the people and inalienable rights were clearly stated in the 1798 constitution. The remnants of feudalism were abolished, and the estates of the Church were confiscated. Though accepted by some of the Swiss, the constitution was opposed by others, and the Swiss were divided into two factions, the Centralists and the Federalists. Napoleon tried to reconcile the factions and in 1802 issued a new constitution.

**Recovery of Independence.** This, like the Helvetic Constitution, could only be maintained by force of arms, and with the French defeat in 1815 the Swiss cantons individually disavowed the French-sponsored government and tried to resurrect the old confederation. But the advantages of a stronger federal union had been clearly seen during the period of French control, and the cantons signed the federal pact on Aug. 7, 1815, continuing the Diet, though with powers greatly modified. The next three decades saw the enactment in Switzerland of reactionary Metternichian measures. Nevertheless, there was evident a steady growth of liberal sentiment in the country, and in 1847 the federal Diet, reflecting this sentiment, ordered the expulsion of the Jesuits, whereupon seven Catholic cantons tried to secede. The federal government, marshaling the military forces of twelve and one-half cantons, very quickly forced the secessionists to capitulate. In 1848, as a result of the War of the Sonderbund, a new constitution was adopted giving the federal government greater powers. This constitution existed until it was replaced in 1874. Possibly the most important aspect of recent Swiss history has been the development of the socialist movement in Switzerland.

**International Developments.** After World War I Switzerland made every effort to find a convenient formula that would enable it to join the League of Nations and yet not jeopardize its policy of neutrality. On Feb. 13, 1920, Switzerland obtained from the Council of the League the recognition that its neutrality was not incompatible with the Covenant of the League. In the May elections the Swiss nation decided by a small majority to enter the League.

For a short time after the end of World War II Swiss public opinion was in favor of Switzerland's entry into the United Nations on conditions similar to those under which it had joined the League of Nations. However, since Switzerland had not declared war on the Axis, it was eliminated at the start from membership. Moreover, the country was criticized by some of the powers, particularly the Soviet Union, for its wartime role and alleged undemocratic practices. As

the tension between the Western powers and the Soviet Union grew, the Swiss attitude toward the United Nations correspondingly changed. Switzerland's strategic position demanded observance of a strict neutrality lest it be involved in a future war. The division of the United Nations into two camps, which had become increasingly obvious, would have jeopardized Switzerland's neutrality had it joined the United Nations.

In April 1946 the League of Nations Liquidation Commission opened negotiations with Switzerland in connection with the League of Nations premises in Geneva and the proposed establishment of a European regional headquarters for the United Nations. In June 1946 the Swiss government informed the United Nations that it would not allow the meetings of the Security Council in Geneva, on the ground that any action ordered by the Council from Swiss soil might be considered a breach in Swiss neutrality. In November Switzerland placed the former premises of the League and a site of more than 144 acres at the disposal of the United Nations with the provision that if the Security Council or Military Staff Committee should move to Geneva they must not order any warlike action from that city. Further, Switzerland has exhibited interest in those United Nations activities which are of a purely economic or humanitarian nature: the International Court of Justice, the Food and Agricultural Organization, and the United Nations Educational, Scientific, and Cultural Organization. The Security Council prescribed special conditions under which Switzerland could become a party to the statute of the International Court of Justice.

To strengthen its international position as a neutral nation, Switzerland attempted at the end of World War II to re-establish diplomatic relations with the Soviet Union, which had been terminated in 1924 as a result of the assassination of a Soviet delegate to the Conference of Sèvres at which the peace treaty with Turkey was deliberated. The first Swiss overtures were turned down by the Soviet Union in December 1944. Largely through the initiative of the Swiss minister to Belgrade the negotiations were resumed, and diplomatic relations were re-established on Mar. 19, 1946. The renewal of diplomatic relations was followed by a series of commercial agreements between the two countries. In January 1950 Switzerland recognized the Communist government of China. W. S. V.

**SWORD.** *See* Arms and Armor (*Edged Weapons*); Duels and Dueling; Fencing.

**SWORD, KNIGHTS OF THE.** *See* Knights of the Sword.

**SWORD FERN,** a popular name for the genus *Nephrolepis* of about 12 ferns of the true fern family, natives of the tropics and subtropics. Some are terrestrial, some epiphytic. Several are grown as house and conservatory plants, especially the popular Boston fern. G. M. Sm.

**SWORDFISH** or **BROADBILL,** *Xiphias gladius,* a large marine fish of the family Xiphiidae with long sword-shaped snout. The flattened snout, short high dorsal fin, toothless mouth, and lack of scales distinguish it from the marlins, *Makaira.* Only one species of swordfish is known. The fastest swimmer of all the fishes, it ranges around the world in warm and temperate seas. It may attain a length of 14 ft. or more. A record individual, which was taken off New England, weighed 1,000 lb. The swordfish is said to charge through schools of fish, killing by striking to either side with its sword, then returning to devour its prey. Sometimes it feeds in water of 100 fathoms; in calm seas it may swim at the surface, with the tip of the dorsal fin and the tail above water, and frequently leaps clear of the surface. Although the swordfish, when hooked, can drive its sword through the planking of a boat, the broken swords which have been found embedded in the bottoms of ships may have been the result of accidental collision. Reported attacks on boats by swordfish were probably made, instead, by marlin. An excellent food fish, the swordfish is also in great demand for the high vitamin content of oil in the liver. It is one of the finest of big game fishes. E. C. R.

**SWORDTAIL,** *Xiphophorus helleri,* a small cyprinodont fish found native in fresh waters of Mexico and Central America. The male is easily recognized by the long lower lobe of the caudal fin, which may be almost as long as the rest of the fish. A favorite aquarium species, the swordtail hybridizes with the platy, *Platypoecilus maculata,* producing many interesting and beautiful varieties. The female may bear from 100 to 200 living young. Thriving on small vegetation such as algae, swordtails are easily kept in a five-gallon aquarium if the temperature is about 75° to 80° F. Since they are active jumpers, the tanks should be covered. The males are pugnacious and too many should not be kept in a small tank. The females are larger, measuring 5 in. in length. The platy, which is similar in form but not so slender, and without the extension of the tail fin, may be kept under the same conditions. E. C. R.

**SWOYERSVILLE** [swɔi′ərzvɪl], a borough in northeastern Pennsylvania, situated in Luzerne Co. on the Susquehanna River, 3 mi. north of Wilkes-Barre. Swoyersville, incorporated as a borough in 1888, is governed by a mayor and council. The borough was named in honor of Henry Swoyer, a coal operator. Coal mining is the chief occupation of the borough's residents. Local factories produce textiles and ornamental iron and steel. Pop. 1950, 7,795.

**SYCAMORE** [sɪ′kəmər], the name given in the United States to the native species of *Platanus.* The Old World species of sycamore are commonly known as plane or plane tree. The common sycamore, *P. occidentalis,* called also buttonwood, of the eastern United States, attains a greater diameter than any other American broadleaf tree, having a trunk 11 ft. in diameter above its enlarged base. It sometimes reaches a height of 170 ft. The reddish-brown bark exfoliates in large, thin scales, exposing irregular patches of a whitish inner bark. The tree has broad, slightly lobed leaves and globular fruit heads suspended on slender stalks. The moderately strong and hard, reddish-brown wood is used principally for furniture and food containers.

The smaller California sycamore, *P. racemosa,* having three- to five-lobed leaves, grows abundantly in valleys from the upper Sacramento to Lower California. It grows to 90 ft. The similar Arizona sycamore, *P. wrighti,* having deeply lobed leaves, is found in Arizona, New Mexico, and Sonora.

The name sycamore was originally applied to *Ficus sycamorus,* a species of fig native to Egypt and Syria. Sycamore is also the commonly accepted name in England for the sycamore maple, *Acer pseudo-platanus.* W. D. B.

**SYDENHAM, THOMAS** [sɪ′dənəm] (1624-1689), British physician, called the "English Hippocrates," was born in Wynford Eagle, Dorset, Sept. 10, 1624. He entered Oxford in 1642, left to enlist in Cromwell's army, but later returned and was graduated as a Bachelor of Medicine in

1648. Sydenham did research study at Montpelier and in 1663 was licensed by the College of Physicians to practice in London. In 1676 he received the degree of Doctor of Medicine from Cambridge University. Sydenham was primarily a great clinician and emphasized personal observation, simple remedies, and the best possible care for the patient. He was the first to differentiate satisfactorily between measles and scarlet fever, and between acute rheumatism and gout. He introduced the cooling method in the treatment of smallpox and fevers, and was one of the first to prescribe iron for anemia. He popularized the use of quinine from cinchona bark in ague or malaria, treated syphilis with mercury compounds, and prescribed a life in the open for phthisis. "Sydenham's laudanum," a tincture of opium with cinnamon, cloves, and saffron added, was a popular remedy for many years. Sydenham made a special study of epidemics in relation to seasons, years, and ages, and revived the Hippocratic idea of "epidemic constitution"; he classified and defined chorea, hysteria, and gout, as well as malaria and smallpox. His conception of infectious conditions as specific entities was far in advance of its time. Sydenham was not a court physician, probably because his radical methods angered and alienated the influential physicians of that period, but his practice included many important people and among his close friends were the chemist Robert Boyle and the philosopher John Locke. Sydenham's fresh approach to the subject of medicine did much to free it from the antiquated theories and practices of the Middle Ages. His writings include treatises in Latin on epidemics, gout, hysteria, smallpox, fevers, and venereal diseases, and discussions of pathology and therapeutics. Sydenham died in London, Dec. 6, 1689. D. D. M.

**SYDENHAM'S CHOREA.** *See* CHOREA.

**SYDNEY,** the capital of New South Wales and largest city of Australasia, situated on the east central coast of Australia in County Cumberland, at 33° 52′ S. lat. and 151° 12′ E. long. It lies 60 mi. south of Newcastle and 450 mi. northeast of Melbourne, at a distance of 6,647 nautical mi. from San Francisco and 4,306 mi. from Singapore. The actual city limits encompass an area of about 9 sq. mi. along the southern shore of Port Jackson, one of the largest and best protected natural harbors in the world; clustered around the city in three directions, southward to the shores of Botany Bay, westward across the Sydney Basin, and northward along the northern shore of Port Jackson, are 48 suburban municipalities which, with Sydney, comprise a metropolitan area inhabited by a fifth of the total population of Australia. The climate is of the modified, humid subtropical type, with an average annual precipitation of 48 in. and an average annual mean temperature of 72° F. July, the coldest month, has an average mean of 52° F.; January, the warmest, 72° F. During the winter (May to September) westerly winds prevail.

Although Captain James Cook sighted and named Port Jackson in 1770, he did not enter it. In January 1788, Captain Arthur Phillip arrived at Botany Bay with a shipload of convicts to establish a British penal station. The colony was removed the same year from Botany Bay to Port Jackson.

COURTESY OF THE AUSTRALIAN NEWS AND INFORMATION BUREAU

*Airview of the harbor at Sydney, New South Wales, Australia, one of the world's finest and most active ports*

At first there were very few free settlers, but after the transportation of convicts from Great Britain was halted, about 1840, the number rapidly increased. The population, only 3,000 in 1815, had grown by 1861 to 97,061 and by 1901 to 487,932; since then the total population of the metropolitan area has tripled.

Public buildings of special note include Government House, a castellated structure in Victorian Gothic style; two cathedrals, Anglican and Roman Catholic; and many buildings of modern architectural design. Adjoining are the Botanic Gardens, notable for their tropical flora, and the National Historical Museum, oldest in the Commonwealth, founded in 1836.

From Dawes Point on the south to Milson Point on the north, a 3,770-ft. bridge, completed in 1932, spans the harbor; it has a main span of 1,652 ft. providing a clearance of 170 ft. for vessels. Port facilities have been extensively developed to make Port Jackson one of the busiest of the British Commonwealth, handling more than 11,000,000 tons of cargo annually. Cockatoo Island is a naval shipbuilding and repair base, with a huge graving dock; here in 1940 and 1941 the *Mauretania, Queen Elizabeth,* and *Queen Mary* were converted for use as troop transports, and later many American warships were repaired. Cultural facilities include the University of Sydney; the public library, with more than half a million volumes; the Mitchell Library of Australiana; a technological museum; a conservatory of music; and art galleries and theatres. The Town Hall is the chief auditorium for concerts. The city and its suburbs constitute the chief industrial, commercial, banking, shipping, and communications center in Australia. The apparel, metalworking, machinery, food and beverage, electrical equipment, and shipbuilding industries are among the more important. Of prime importance in the local economy is wool marketing. Chief exports, besides wool, include wheat, meat, butter, and fruit. Pop. 1947, 1,484,434. W. McE.

**SYDNEY,** a port city and the county town of Cape Breton Co., Nova Scotia, Canada, situated on a good harbor, about 200 mi. northeast of Halifax. Rail facilities are provided by the Sydney and Louisburg and the Canadian National railways. Air service is furnished by the Trans-Canada Air Lines. The city has steamer connections with the Bras d'Or Lake ports, northern Cape Breton, Prince Edward Island, and Newfoundland. Founded in 1784, Sydney was incorporated as a town in 1885 and as a city in 1904. Nearby are the extensive Cape Breton coal fields. Large quantities of coal are shipped from the city to St. Lawrence River ports. Iron ore is brought by ship from Bell Island, Newfoundland, for processing in Sydney, which is one of the most important steel centers in Canada. Rails, ship plates, nails, and wire are leading products of the city's industries. Pop. 1951, 31,317. D. F. P.

**SYDNEY, UNIVERSITY OF,** at Sydney, Australia, on a campus of 140 acres. The university was incorporated by an act of the legislature of New South Wales, which received the Royal Assent of Great Britain on Oct. 1, 1850. By a royal charter, issued on Feb. 7, 1858, the graduates of the University of Sydney were accorded the same status as that of other university graduates within the United Kingdom. A number of colleges are included within the organization of the university: St. Paul's (Anglican), St. John's (Roman Catholic), St. Andrew's (Presbyterian), Wesley (Methodist), Women's (undenominational), and Sancta Sophia (Roman Catholic Women). New England University at Armidale is an associate college. The teaching staff includes faculties of agriculture, architecture, arts, dentistry, economics, engineering, law, medicine, science, and veterinary science. A. L. H-Q.

**SYDNEY MINES,** a town in Cape Breton Co., Nova Scotia, Canada, situated on Sydney Harbor, 8 mi. north of Sydney and 200 mi. northeast of Halifax. It is on Provincial Highway 5 and is served by the Canadian National Railways. It was incorporated in 1889. It is the North American terminus of a transatlantic cable. Coal mining is the chief occupation of the district. About 800,000 tons of coal are mined annually. Pop. 1951, 8,410. D. F. P.

**SYENITE** [sai′ənait], an intrusive igneous rock similar to granite in appearance, but containing little or no quartz. Essential minerals are potash feldspar, with lesser amounts of plagioclase feldspar (oligoclase), hornblende, biotite, and pyroxene. Common accessory minerals are apatite, magnetite, sphene, and zircon. Syenite, by an increase in quartz content, grades into granite; an increase in plagioclase makes it a monzonite; and an increase in both quartz and plagioclase produces granodiorite. On the other hand, an increase in the darker minerals, accompanied by a change of feldspar from the potash-soda to the soda-lime types, causes syenite to pass into diorite. Changes in texture from granitoid to porphyritic result in syenite porphyry, and the fine-grained border zones of syenite intrusions are trachytic. Nepheline syenite is a variety containing greasy-looking grains of the feldspathoid nepheline. Sodalite or corundum may also be present in these rocks. Both syenite and nepheline syenite occur in large intrusive bodies, which, however, are by no means as extensive or widespread as are the granite batholiths. Syenite rocks occur in the White Mountains of New Hampshire, in northern Wisconsin, south and west of Little Rock, Arkansas, and, in Europe, in especially well-known exposures in the vicinity of Oslo. It is quarried to a minor extent and marketed as granite. Nepheline syenite, on the other hand, has separate use as a substitute for feldspar in the manufacture of glass and other ceramic products. It is exploited for this purpose in Ontario, Canada, and in the U.S.S.R. About 40,000 tons of Canadian nepheline syenite is imported annually into the United States. K. K. L.

**SYLACAUGA** [sɪləkɔ′gə], a city in central Alabama, situated in Talladega Co., 40 mi. southeast of Birmingham, in an agricultural area where corn, cotton, and hay are important crops. Pine timber and marble are natural resources of the region. In 1950 the government was of the mayor-council type. Sylacauga has the distinction of having supplied from its quarries marble for such world-famous buildings as the presidential palace in Havana, Cuba, and the United States Supreme Court Building in Washington, D.C. Transportation is afforded by the Central of Georgia and the Louisville & Nashville railroads. In addition to marble, local industries include cotton ginning and the manufacture of cottonseed oil, cotton cloth, mattresses, caskets, soft drinks, fertilizer, lumber, and bricks. Pop. 1950, 9,606.

**SYLLABLE,** in linguistic science, a unit of utterance which is variously defined. The concept expressed by the term *syllable* is by no means clear, and it has provoked much discussion, some phoneticians going so far as to deny its validity altogether.

The existence of the entity called "syllable" is assumed in the metrics of most languages, which are based, in great part, and sometimes predominantly, on a count of syllables.

Thus Sanskrit, Greek, and Latin metrics are based on a certain number of long and short syllables, alternating with each other according to certain schemes. The number of syllables is strictly observed in Vedic and Classical Sanskrit verse and in Greek and Latin Alcaics, Sapphics, and other Aeolic verse forms. In Greek and Latin epic and tragic verse it is limited to a certain range; for example, the epic hexameter of Homer and Vergil is limited to no less than 12 and no more than 17 syllables, the two extremes being comparatively rare. Among the modern languages, those of the Romance group are relatively strict in the matter of syllable counting; Italian verses, indeed, receive their names from the number of syllables they contain (*settenario, ottonario, novenario, decasillabo, endecasillabo, dodecasillabo,* etc.). The ancient Germanic verse (as found in the *Edda* or *Beowulf,* for example) was much freer, and some of this freedom still survives in modern English and German poetry. However, an arbitrary alteration of the number of syllables in a verse shocks a reader of English poetry probably no less than it shocks a reader of Italian, and this sensitivity offers excellent evidence of the existence of the syllable as a clear acoustic entity. In fact, the syllable is perhaps best defined in precisely those terms, as a unit of utterance that constitutes "a clear acoustic entity."

One widely accepted definition of the syllable, "a word, or a section of a word, containing a single vowel," is dangerously close to being tautological, for a vowel may be defined as a sound that is capable, in itself, of forming a syllable. Thus, *oil* may be called a syllable on the ground that it contains only one vowel, inasmuch as the *i* is essentially a consonant or a half consonant (usually called a *semivowel*); but this reasoning is circular, for all that prevents the *i* in *oil* from being a vowel is the fact that it is not syllabic. Moreover, sounds that from the point of view of their articulation are usually considered consonants, such as *r, l, m, n, z,* and *s,* occasionally "carry" the syllable and so perform the essential function of vowels. Thus, in English, the *l* of *battle* and the *m* of *rhythm* are called "syllabic" or "vocalic," and similar sounds existed in Indo-European and still exist in German and in several Slavic languages. In like manner, the *s* in *pst, sst,* and similar articulations may be called syllabic, for even though it is voiceless, it has the vocalic element of duration.

In general, every syllable is marked by a single high pitch of sonority. It follows that syllables are separated by depressions of sonority, which are usually represented by consonants, but sometimes simply by a short silence or hiatus (as in *naïve*). The lowest depression of sonority is the limit or boundary between the syllables; it varies a great deal in the different languages, and is by no means easy to recognize.

Syllables are called checked or closed when they end in a consonant (Lat. *ac, nec, et;* Eng. *as, pot, fat*); unchecked or open when they end in a vowel (Lat. *nē, dā;* Eng. *bee, she*). When the vowels of two successive syllables are separated by a single consonant, this consonant belongs, in Greek, Latin, and the Romance languages, to the following syllable. Thus, the first syllable of Latin *a-mor,* French *a-mour,* Italian *a-more,* and Spanish *a-mor* is open. On the other hand, when the two vowels are separated by two consonants (as in Latin *fac-tum,* Italian *can-to,* French *par-tage*), usually the first consonant goes with the preceding syllable (which is closed), and the second with the following syllable. When three or four consonants appear between two vowels, the first consonant usually belongs to the first syllable, the others to the following (Latin *cas-tra, tem-plum*). These rules also apply in general to English, with the exception that a consonant following a short vowel is usually regarded as belonging to the preceding syllable (*nev-er, cit-ies, ad-amant*). The division of syllables at the end of the written or printed line is in some cases arbitrary and does not correspond to the real syllabification; it is frequently based on the etymology rather than the sound of words.

Some indirect conclusions as to the division between syllables can be drawn from the metric of quantitative languages and, in some cases, from historical linguistics. In Greek and Latin metrics a closed syllable is always considered long, just as an open syllable is long when it contains a long vowel. It follows that *făctum,* which (like *fātum*) constitutes a trochaic foot (— ◡), must be divided *făc-tum,* for its first syllable has a short vowel and could not fulfill its function in the trochee if it were not closed.

An exception may be made, both in Greek and in Latin metrics, for the so-called *positio debilis* ("weak position"), which arises when an occlusive is followed by *m, n, r,* or *l.* In words like *pătrem, intĕgrum,* or *tenĕbrae,* for example, the penultimate syllable can be either short or long, as the poet chooses. The Romance languages show that in spoken Latin the short articulation prevailed in the end, for these languages regularly have an open syllable in these cases: French *père* from Latin *pa-trem, entier* from *intĕgrum,* Spanish *tinieblas* from *tenĕbrae.* However, the penultimate syllable of *tenebrae* and *integrum* must have been long at some time, for otherwise the accent would be on the antepenult in accordance with the laws of Latin accent.

Many languages show a trend toward a certain quantitative equalization of syllables, shortening those that are relatively long and lengthening those that are relatively short. Latin, for example, shortens all long vowels before the combination of a nasal or liquid with a stop; thus **calēntem,* from **calēre,* becomes *calĕntem,* Spanish *caliente.* The same development takes place in Greek and in Lithuanian. In the Romance languages, which have lost the Latin distinction between short and long vowels, all vowels in open syllables tend to become long and all vowels in closed syllables tend to become short. Thus Italian has *fā-to, dā-to, viē-ne, pā-ni,* and also *făt-to, găt-to, vĕn-ne, păn-ni.* Since in closed syllables the consonants add a certain length of time to the articulation of the syllable, all syllables thus tend to equality of duration. Some languages, including Japanese, have only open syllables (*Hirohita, Hiroshima, Nagasaki,* etc.), and Protoslavic approaches the same condition. This tendency, which is frequent in many languages, is also discernible in French and Spanish, Latin *testa* becoming (bisyllabic) French *tête* and *factam* becoming (bisyllabic) *faite.* However, in recent times French has started dropping the so-called "mute *e*," and thereby many syllables that were once open become closed again. Thus many consonantic groups, which had long disappeared from the language, have now been revived, and groups that never existed (such as *šv* in *cheval,* now pronounced *šval*) are appearing. This tendency is favored, in French as in all modern European languages, by the introduction of enormous numbers of foreign learned words, especially of Italian, Latin and Greek origin.

In all modern European languages, stressed syllables are, as a rule, longer and stronger than unstressed ones. In the Germanic languages, especially, the consequence has been that unstressed syllables weaken or fall, Latin *eleēmosynās* becoming English *alms* and *paraverēdus* becoming German *Pferd.* The same trend exists, in a weaker degree, in the Romance languages, in Russian, and elsewhere; thus French has *manger* for Latin *manducāre* and *août* for *augustum.* It appears that there was no such trend in ancient languages in which pitch rather than quantity predominated.

The number of syllables in a word has an important effect on the duration of the component syllables. Other things being equal, the monosyllable is, as a rule, longer than either of the syllables of a bisyllabic word, and each of these is longer than any of the syllables in a polysyllabic word. The longer the word, in fact, the shorter the syllable. The monosyllable *pork* is longer than the syllable *pork-* in *porker,* and this in turn is longer than the *porc-* in *porcupine.*

The number of syllables composing a word varies enormously from one language to another. Chinese, at least in its literary variety, has only monosyllables. Monosyllables are very frequent in English; in fact, the Germanic element in English is almost exclusively monosyllabic. French and German have many monosyllables, whereas Italian has almost none and Spanish very few. There is in Europe a general trend toward a reduction in the size of words, but in some languages, including the Slavic ones and Spanish and Italian, this trend has not gone very far. In English, while most Germanic words and many others that are in common use are monosyllabic, the learned words, whether French, Italian, Latin, or especially Greek, are in their vast majority polysyllabic. This division in the English vocabulary suggests to many speakers of English the notion that polysyllabics are learned, pretentious, technical, and pedantic words, which the average mind does not understand and the average man does not use. The English language is therefore virtually split into two sections, and the gap shows no sign of closing. The same gap exists in several other European languages, and it is widened, as it is in English also, by the special consonantic clusters that characterize learned words of Latin and Greek origin.

The tendency of spoken English toward monosyllabism is also apparent in abbreviations and nicknames, which are usually monosyllabic (e.g., *Jap, Kraut, Yank; Jim, Jack, Fred*). In French and in Italian, abbreviations are usually bisyllabic, French having *le métro* (*le métropolitain*), *le bachot* (*le baccalauréat*), *Loulou, Nana, Fifi, Mimi, Kiki,* and Italian having *Gigi, Gianni, Toto,* and many more.

G. B.

**SYLLOGISM.** *See* Logic.

**SYLPHIDES, LES** [lɛ si'lfi'd], an abstract ballet in one scene by Michel Fokine, danced to orchestrations of piano selections of Frédéric Chopin. Using the same music, Fokine originally prepared an elaborate ballet called *Chopiniana,* which was first presented at the Maryinsky Theatre in St. Petersburg on Mar. 21, 1908. This was soon transferred into the classically simple *Les Sylphides,* which had its première at the Théâtre du Chatelet in Paris on June 2, 1909, during the first Parisian season of the Diaghilev company. Perennial opening number for ballet programs, *Les Sylphides* has probably been presented more times than any other ballet. Anna Pavlova, who appeared with Vaslav Nijinsky in its first performance, often included in her programs a ballet called *Chopiniana,* which was probably an adaptation of the original version of *Les Sylphides.*

The costumes worn by the female dancers in *Les Sylphides* were designed in the early nineteenth century by the painter Eugène Lami (1800-1890) for *La Sylphide,* a ballet in two acts by Filippo Taglioni to a score by Jean Schneitzhoeffer. The libretto of this early work was by Adolphe Nourrit, tenor of the Paris Opéra, and was based in part upon the novel *Trilby, ou Le Lutin d'Angail* (1822) by Charles Nodier. Maria Taglioni as Sylphide wore the so-called long *tutu,* which became the traditional costume of the Romantic ballet. *See also* Ballet.

F. G. P.

**SYLT** [zɪ'lt], a German island in the North Sea, the largest of the North Frisian Islands. It lies off the west coast of the Jutland peninsula opposite the Danish-German frontier. Sylt is 22 mi. long from north to south and in most parts less than a mile wide, except near the middle of the island where a peninsula extends 7 mi. eastward. The total area is about 37 sq. mi. The interior is low, for the most part, with marshes, heath, and moor predominating.

Sylt was virtually independent during the Middle Ages; it became part of the Duchy of Schleswig in 1435. The island was invaded by Sweden in 1643 and held for a year by the Swedes before they were driven out. The Danes had possession in 1864 during their war with Prussia, but the Prussians captured the island before the end of the war and it has remained in German hands since. Fortified in the 1930's, Sylt was the first German territory bombed in World War II, and after the war was included in the British zone of occupation. Sylt, connected to the mainland by rail via the Hindenburgdamm, a causeway, is a popular resort and its main source of income is the tourist trade. Keitum is the largest town on the island, while Westerland and Kampen are two of the most popular resort villages. Despite protective measures, the island is continually menaced by the erosive action of the sea, which has washed away considerable land over the years. Pop. 1950, 22,238.

C. C. H.

**SYLVAN LAKE PARK.** *See* Canadian Provincial Parks.

**SYLVANUS.** *See* Silvanus.

**SYLVESTER I, ST.** (c.275-335), a Roman by birth, became pope in 314, shortly after Constantine had revolutionized religious conditions in the Roman Empire by showing official favor to Christianity. For lack of authentic information, many legends became attached to Sylvester's name in the course of centuries. The best known is the so-called "Donation of Constantine," a document which relates how Constantine, who was afflicted with leprosy, sought out Sylvester in his hiding place on Mount Soracte and was baptized after being cured by the pontiff. In return Constantine is said to have granted Sylvester the privilege of wearing imperial insignia, and to have given him not only supremacy over all the Christian churches of the Empire, but also temporal dominion of Rome, Italy, and the West. This document is an early medieval forgery. Reliable information on Sylvester is scanty despite his long pontificate (314-335). His feast is celebrated Dec. 31.

E. A. R.

**SYLVESTRINES** [sɪlvɛ'strɪnz], members of a Roman Catholic minor monastic congregation that was founded by St. Sylvester Gozzolini at Monte Fano near Fabriano, Italy, in 1231, and approved by Pope Innocent IV in 1247. Following the strictest form of the Rule of St. Benedict, yet not federated with other Benedictine congregations, the blue-clad Sylvestrines place great stress on poverty. Long confined almost exclusively to Italy, the congregation established a mission in Ceylon in 1855. In 1942 the congregation numbered one hundred and twelve professed monks. In 1947 there were twelve in the diocese of Detroit, where they were established in 1910. The Sylvestrine nuns have never been numerous.

W. C.

**SYMBIOSIS** [sɪ'mbaio'sɪs], or mutualism, an intimate association of two different organisms, the symbionts, in which each is benefited by the partnership. There are degrees of symbiosis, just as there are degrees of parasitism.

The partnership is sometimes essential to the life of each symbiont, the death of one often resulting in the death of the other. But the association is not always so strict, for each symbiont, if conditions warrant, may be capable of independent existence. However, growth and multiplication are more vigorous in association than when either species lives alone. In still other instances, the balance may be so delicate that, if one of the symbionts is favored, it will outgrow the other and eventually become a parasite, or predator, on its associate.

The phenomenon of symbiosis occurs in most of the plant and animal phyla. The association between leguminous plants and nitrogen-fixing bacteria is an excellent example. The bacteria cause the roots to develop nodules, and take their nourishment from the plant, in return for which they transform atmospheric nitrogen into compounds which the plant can utilize. Many bacteria live symbiotically with other organisms. Cellulose-eating animals, such as the horse, the cow, and the sheep, have bacteria in their stomachs which partially digest their food. In exchange, the bacteria receive all their food from them.

Another example of symbiosis is found in the lichens. These plants represent intimate associations between various species of colorless plants (fungi) and unicellular green plants (algae). The fungus supplies attachment and protection, and absorbs the raw materials of food. In turn, the fungus obtains the photosynthetic products from the algae. Each can live independently under favorable conditions, but in partnership they can withstand hardships which many plants cannot. Thus lichens often populate rocky regions which otherwise would be barren.

Symbiotic relations between unicellular green (Zoochlorellae) and brown or yellow algae (Zooxanthellae) and animals are not uncommon. Here the algal symbiont supplies the organic products of photosynthesis, while the animal, in return, affords a favorable abode and materials necessary for the life of the chlorophyll-bearing organisms. Zoochlorellae are found living in association with fresh-water protozoa such as *Paramecium bursaria, Stentor polymorpha,* and *Stentor amethystinus.* Among the fresh-water Metazoa, these green algae are associated with *Chlorohydra viridissima* and with certain fresh-water sponges. Zooxanthellae are found living with marine Protozoa such as *Paraeuplotes tortugensis,* and with certain Foraminifera and Radiolaria. Similar algae are found associated with certain corals (Millepora), sea anemones, and in certain flatworms (e.g. Convoluta).

Symbiotic relations between Protozoa and Metazoa also occur. The protozoan symbionts are usually found in the stomach and intestine of wood-eating animals, such as termites and wood roaches. They perform the same function as do the cellulose-digesting bacteria. The association of the termites and their Protozoa is strict; neither can live without the other.

An instance of symbiosis between two Metazoa is that involving the hermit crab and sea anemones: the latter give additional protection to the crab by concealing it, and by means of many poisonous stinging threads with which their tentacles are covered. The anemones in turn are transported from place to place into new feeding grounds, and also may gather in food which is missed by the crab. Another interesting example is represented by ants and plant lice, or aphids. The defenseless aphids are protected, herded, and "milked" by the ants in order to obtain honeydew from them, a secretion of the plant lice, which the ants eat. R. F. N.

**SYMBOLIC LOGIC** (or mathematical logic), the science of correct inference, especially as developed by use of mathematical methods and with the help of special symbols that enable one to avoid much of the ambiguity of ordinary language.

This field of study arose in the eighteenth and nineteenth centuries as an outgrowth from both traditional mathematics and the ancient logic of Aristotle. It joined these hitherto diverse subjects into a single subject, or at least provided them with a common foundation. The earliest writers on symbolic logic were such mathematicians and philosophers as G. W. Leibniz, George Boole, C. S. Peirce, Gottlob Frege, Ernst Schröder, and Giuseppe Peano. During the first half of the twentieth century numerous important contributions to the subject were made by scholars in Europe, Great Britain, and the United States. Especially notable among European scholars were David Hilbert and Kurt Gödel. Some of the well-known British and American contributors were Bertrand Russell, A. N. Whitehead, H. M. Sheffer, E. L. Post, C. I. Lewis, Alonzo Church, H. B. Curry, and W. V. Quine.

Symbolic logic seeks to attain all the rigor and clarity of the most exact mathematics, but without the restrictions that limit ordinary mathematics to dealing only with numbers and numerical relationships. Any subject-matter whatsoever is susceptible to analysis by symbolic logic. Much use is made of the notions of "class" (as in any classification), "relationship," and "proposition." A great weakness of Aristotelian logic was its lack of any adequate account of the logical nature and structure of relationships. Until the advent of symbolic logic, no systematic way had been provided for reasoning about any relationships other than those appearing in geometry or in numerical mathematics. This perhaps accounted in part for the great advances that had been made by the physical sciences in contrast to the lesser progress achieved by ethics, political science, philosophy, and the social sciences generally. The first important application of symbolic logic to an empirical science occurred in 1937 with the appearance of J. H. Woodger's book, *The Axiomatic Method in Biology.* Subsequent writers have applied symbolic logic to psychology and neurophysiology.

The problem of proving that certain systems of mathematical logic are free from contradiction has been regarded as a crucial problem by symbolic logicians ever since some previously acceptable methods of reasoning were found to give rise to contradictions. The sort of contradiction that may be obtained by use of such previously acceptable methods is well illustrated by the Russell Paradox (discovered by Bertrand Russell), which may be stated as follows: Let $Z$ be the class of those classes which are not members of themselves. (For example, the class of all books is not itself a book. Hence it is not a member of itself. Hence it is a member of $Z$.) Now either $Z$ is a member of $Z$, or else $Z$ is not a member of $Z$. If $Z$ is a member of $Z$, then $Z$ is a member of itself, so $Z$ is not a member of $Z$ after all. On the other hand, if $Z$ is not a member of $Z$, then $Z$ is one of those classes which are not members of themselves, and so $Z$ is after all a member of $Z$. Hence, paradoxically, $Z$ can neither be a member of itself nor fail to be a member of itself. Paradoxes of this kind can be avoided by various more or less satisfactory methods. One of these methods is the "theory of types," according to which a class always is treated as being of a different "type" from its members, and any assertion or denial that a class is a member of itself is regarded as "meaningless" owing to a confusion of types. Thus it becomes a meaningless question to ask whether or not $Z$ is a member of $Z$.

There is no complete uniformity or standardization in the choice of symbols employed by writers in symbolic logic, but there is a certain amount of agreement. The following table

illustrates approximately and in part the kind of notation that is most commonly employed:

| *Symbolic Expression.* | *Meaning of the Expression.* |
|---|---|
| $a=b$ | $a$ is identical with $b$. |
| $\backsim(a=b)$ | $a$ is not identical with $b$. |
| $p\cdot q$ | (It is the case that) $p$ and $q$ (are both true). |
| $p \mathrm{v} q$ | (It is the case that) $p$ or $q$ (is true). |
| $\backsim p$ | Not $p$. (Or: $p$ is false.) (Or: It is not the case that $p$.) |
| $p \supset q$ | If $p$ then $q$. (Or: $p$ only if $q$.) |
| $p \equiv q$ | $p$ if and only if $q$. |
| $a \in b$ | $a$ is a member of $b$. |
| $\backsim(a \epsilon b)$ | $a$ is not a member of $b$. |
| $a \subset o$ | $a$ is included in $b$. (Or: Every member of $a$ is a member of $b$.) (Or: $a$ is a subclass of $b$.) |
| $Fa$ | $a$ has the attribute $F$. |
| $(\exists x)$ | There is something $x$ such that . . . |
| $(\exists x)Fx$ | There is something $x$ such that $x$ has the attribute $F$. (Or: Something has the attribute $F$.) |
| $(\exists x)(x=a)$ | There is something $x$ such that $x$ is identical with $a$. (Or: Something is identical with $a$.) |
| $(x)$ | Each thing $x$ is such that . . . |
| $(x)(x=x)$ | Each thing $x$ is such that $x$ is identical with $x$. (Or: Each thing is identical with itself.) |
| $(\hat{x})$ | The class of things $x$ such that . . . |
| $\hat{x}Fx$ | The class of things $x$ such that $x$ has the attribute $F$. (Or: The class of things having the attribute $F$.) |
| $(a \epsilon \hat{x}Fx) \equiv Fa$ | $a$ is a member of the class of things having the attribute $F$ if and only if $a$ has the attribute $F$. |
| $Fa \supset (a \epsilon \hat{x}(Fx \mathrm{v} Gx))$ | If $a$ has the attribute $F$ then $a$ is a member of the class of things having the attribute $F$ or the attribute $G$. |
| $((a \epsilon b) \cdot (b \subset c)) \supset (a \epsilon c)$ | If $a$ is a member of $b$, and $b$ is included in $c$, then $a$ is a member of $c$. |

The last three symbolic expressions above (as well as "$(\exists x)\ (x=a)$" and "$(x)\ (x=x)$") are illustrations of expressions that are regarded true on logical grounds alone. Such expressions would be expected to appear as theorems in any fairly adequate system of logic.

In formulating a system of symbolic logic it is usual to specify which expressions are regarded as "axioms" of the system and then to state certain "rules of procedure" according to which other expressions, known as "theorems" of the system, are derivable from the axioms or from previously derived theorems. This process is supposed to require no reference to the actual or possible meanings of the symbols concerned, and so is said to belong to the "syntax" of the system concerned. The "semantics" of a system, on the other hand, does involve the assignment of meanings to various expressions of the system, but it is not concerned with indicating which expressions are axioms or theorems of the system.

*See also* Russell, Bertrand A. W. F. B. F.

**SYMBOLISTS,** a group of French poets of the end of the nineteenth century, among whom are included Stéphane Mallarmé, Jules Laforgue, Gustave Kahn, Francis Viélé-Griffin, Stuart Merrill, Jean Moréas, Paul Fort, Maurice Maeterlinck, Remy de Gourmont, Emile Verhaeren, Henri de Régnier, Albert Samain, René Ghil, Francis Jammes, and others. Arthur Rimbaud and Paul Verlaine are sometimes considered forerunners of the movement, and among the poets of the twentieth century, Paul Valéry and Paul Claudel are sometimes presented as the direct heirs of the Symbolists.

Symbolism, like Impressionism in painting, is an attempt to abandon ready-made patterns and rules and to seize purer and more essential qualities in the artistic medium. Valéry has defined Symbolism as a common attempt, made by schools of poetry which often seemed at odds, to borrow for poetry the properties of music. This definition includes in its scope such poets as Mallarmé, Verlaine, Laforgue, and Ghil, who were all musical in different ways. All tried to lift French poetry out of its traditional oratory and to use words not for their expository qualities but for their shades and undertones of meaning. The union of the arts, the fusion of sensations, abstract words used concretely, and concrete words used adjectivally are some of the devices that they employed. At the root of all these experiments lay a belief in the supremacy of art over every other means of expression or knowledge, a belief incorporated in an idealistic philosophy: the world that humans look at is not the world they would see if they knew it through the "correspondences" that their various senses could establish among sensations.

After 1900, there was a strong reaction against the Symbolists. They were considered café poets, lacking in vigor, too fond of artificial ornaments, and too much like J. K. Huysmans' hero, Des Esseintes. Nevertheless, the literary experiments of Symbolism cannot be dismissed. Among these, the most important is free verse, which resulted from a long process of dissolution of traditional forms and has now become an important department of poetry. The attacks the Symbolists faced were often undeserved. There existed indeed a "fin de Siècle" or "decadent" affectation and a foggy or atmospheric type of art which were identified by some with Symbolism; but at no time since the Renaissance have so many experiments been carried out on the poetic values of words, and no school of poetry has so much enriched the technical means of poets.

The Symbolist movement in the theatre is best represented by Maurice Maeterlinck, who tried to revive the poetic drama and dissolve the characters of his plays in thematic composition. Among the adherents of the movement was one ex-

cellent critic, Remy de Gourmont. As for the novel, Proust's works can be considered as a brilliant finale to the life and the ideas of the Symbolist period. R. Ta.

**SYMMACHUS, ST.** [sĭ'məkəs] (c. 450-514), pope, born a pagan in Sardinia, was baptized at Rome. In the troubles following the death of Anastasius II, whose policy in regard to the schism of Acacius was unpopular, Symmachus was elected pope by the anti-Byzantine majority. The faction of Anastasius opposed to him the priest Laurentius. Both sides appealed to Theodoric the Great, who decided in favor of Symmachus. The early years of the pontificate, 498-506, were troubled by charges and countercharges. Notable is the decision of the Roman Synod of 501, which declared that the quarrels must be submitted to the tribunal of God since the chair of Peter must not be judged by any man. It was only in 506, when Theodoric vigorously supported the cause of Symmachus, that the Laurentian schism ceased to divide the Roman Church. The violent persecution of the orthodox Eastern Christians by the Monophysite emperor Anastasius prevented Symmachus from healing the schism between Rome and Constantinople. E. A. R.

**SYMONDS, JOHN ADDINGTON** [sĭ'mənz] (1840-1893), English historian, scholar, poet, was born in Bristol on Oct. 5, 1840. He was educated at Harrow and at Oxford, and he remained at the latter for some time as a tutor. His most important work, the *History of the Renaissance in Italy* (1875-1886), is rich in valuable comment and picturesque detail, although it is not a highly unified study nor a continuous one. In 1887 he translated the *Autobiography of Benvenuto Cellini*. He wrote brief studies of Jonson, Sidney, and Shelley. His verse is best represented by *Many Moods* (1878) and *New and Old* (1880). He translated the Greek poets and the sonnets of Michelangelo and Campanella. Symonds died in Rome on April 19, 1893. C. D.

**SYMONS, ARTHUR** [sai'mənz] (1865-1945), English editor, poet, and critic, was born in Wales, on Feb. 28, 1865, of Cornish parents. In the eighties and early nineties he wrote for the *Athenaeum,* the *Saturday Review,* and the *Academy*. He contributed frequently to the *Yellow Book,* and in 1896 he founded the short-lived but brilliant *Savoy*. His criticism, impressionistic and trenchant, ranged over a variety of subjects in both French and English literature, some of his best-known critical works being *The Symbolist Movement in Literature* (1899), *The Romantic Movement in English Poetry* (1909), and *Studies in Elizabethan Drama* (1920). Symons' poetry is in the decadent tradition characteristic of the nineties. His volumes of poems, *Days and Nights* (1889), *Silhouettes* (1892), and *London Nights* (1895), indicate his general disillusionment and illustrate the perfection of his technique. He died in Wittersham, Kent, on Jan. 22, 1945. C. D.

**SYMPATHETIC INK.** *See* Inks.

**SYMPATHETIC NERVOUS SYSTEM.** *See* Nervous System (*Autonomic Nervous System*).

**SYMPHONIC POEM** or **TONE POEM,** a one-movement orchestral composition based on a poetic or other nonmusical "program" and treated in the manner of the symphony; it is chiefly identified with nineteenth-century Romanticism. The ancestor of the symphonic poem, which was evolved and popularized by Franz Liszt around the middle of the nineteenth century, was the program symphony, examples of which are Beethoven's *Pastoral Symphony* (first published 1809) and Berlioz' *Symphonie Fantastique* (1831). Liszt also wrote program symphonies in "Dante" (1856) and "Faust" (1857); the chief differences between them and his thirteen symphonic poems, especially *Prometheus* (1856), *Tasso* (first published 1856), and the very popular *Les Préludes* (first published 1856), are the greater influence of the program in the symphonic poems on the character and form of the music, and the use there of but one movement, although that may be subdivided into sections of considerable contrast.

Where Liszt's programs had been chiefly ideas, subsequent composers often based their works on more concrete subjects and treated them more literally. Among celebrated examples, Smetana's *The Moldau* (from the suite *My Country,* 1879) patriotically depicts the course of the great Bohemian river, Saint-Saëns' *La Danse macabre* (1874) (*The Dance of Death*) describes a grotesque graveyard frolic, Tchaikovsky's *Romeo and Juliet* (1870) emphasizes the main forces and conflicts in the Shakespeare classic, and Paul Dukas's *The Sorcerer's Apprentice* (1897) relates an amusingly dramatic incident. On the other hand, Debussy's *Prelude to the Afternoon of a Faun* (1894) merely reflects moods and impressions.

Richard Strauss's literal and highly successful tone poems, especially *Don Juan* (1888), *Death and Transfiguration* (1889), *Till Eulenspiegel's Merry Pranks* (1895), and *A Hero's Life* (1898), qualify him as the principal successor to Liszt and perhaps the greatest composer of symphonic poems. But while Arthur Honegger, in *Pacific 231* (1924), and Alexander Mossolov, in *The Steel Foundry* (1930), have attained at least as great a degree of literalism in the twentieth century, many twentieth-century composers have turned away from program music in general. However, in spite of time-honored objections to a dependence on extramusical factors, one may note that the best nineteenth-century symphonic poems, quite apart from their programs, are constructed according to the soundest principles of "absolute" music. W. S. N.

**SYMPHONY,** an extended musical composition for orchestra, usually in four contrasting movements, following the plan of the sonata. The word "symphony," which has a connotation of "consonance" or "harmony" in its original Greek form, was first generally employed to designate a musical composition in the early seventeenth century. Until the second quarter of the eighteenth century, however, in its Italian form (sinfonia) it meant an introductory piece of some sort, especially an overture to an operatic work. Nevertheless, the three-movement (fast-slow-fast) opera sinfonia, evolved at the end of the seventeenth century by Alessandro Scarlatti and others, was an important ancestor of the modern symphony. Its significance was demonstrated by the sinfonie that were composed independently of opera and performed as concert pieces, such as the early sinfonie by Giovanni Battista Sammartini (1701-1775).

The modern symphony is the instrumental product par excellence of the fully developed Classical era, the first great examples being among the most mature works of Mozart and Joseph Haydn. Many other antecedents of musical Classicism beside the Italian sinfonia contributed to produce the modern symphony around the middle of the eighteenth century. Of prime importance were major refinements in the art of orchestration: the strings became the melodic foundation, and the figured bass was discarded, an act which resulted in more precise harmonic and soloistic assignments for the wind instruments. Notable among the composers who brought about these orchestral refinements were Jean Philippe Rameau and François Joseph Gossec in Paris, Johann Stamitz in Mann-

heim, C. P. E. Bach in Hamburg, and Haydn and Mozart in Vienna. Also of great importance to the development of the symphony, and in part influenced by the new orchestration, were the trends toward broader, more pliant themes, capable of varied development, dissection, and expansion; a more homophonic texture, at its best enlivened by the interplay of thematic motives in harmonic counterpoint; the clear opposition of moods or ideas, both within a single theme and between contrasting themes; and highly organized, sectional designs, in particular that design subsequently known as "sonata form."

Among the larger Classical instrumental forms, all of which followed the sonata form more or less closely, the symphony was quite naturally given the most extensive treatment since its "instrument" (the orchestra) provided the widest range of expression. In the main, the Classical symphony represented a more serious and developed treatment of the sonata idea than either the solo keyboard sonata or the string quartet. It made more extensive use of the introduction, the bridge, and the coda; it exploited its material more thoroughly; and it achieved greater climaxes and contrasts. A further distinction was to be found in the use of a minuet or, beginning with Beethoven, a scherzo before the finale of the symphony; this was used in the principal chamber-music forms but not, as a rule, in either the concerto or the solo sonata.

Although Haydn wrote at least 104 symphonies in the usual eighteenth-century sets of three or more, and Mozart forty-one, only a few of their last and greatest symphonies are frequently performed. These include the E-flat major, G-minor, and C-major, or "Jupiter," symphonies written in 1788 by Mozart and the "Surprise" (G-major, 1791), "Military" G-major, 1794), and "Clock" (D-major, 1794) symphonies among the twelve written by Haydn between 1791 and 1795 for the London impresario Johann Peter Salomon. Subsequent composers preferred to write fewer symphonies, endeavoring to imbue each with relatively more distinctive and consequential character.

The nine symphonies by Beethoven—including the Third in E-flat major ("Eroica," 1804), the Fifth in C-minor ("Fate," 1805), and the Ninth in D-minor (known as the "Choral Symphony" because of the introduction of soloists and chorus in the finale, 1823)—mark a peak in symphonic literature, being unexcelled in formal logic and intensity of expression. Fitting successors are the nine symphonies of Schubert, especially the "Unfinished" (the Eighth in B-minor, 1822), a work of great melodic and dramatic power which the composer cast aside after completing only two movements, and the monumental and heroic Ninth in C-major (1828), which was called the "Seventh" in the days before the scores of the "Unfinished" and a fragmentary E-minor symphony (1821) had been discovered. Beethoven and Schubert both combined elements of Classicism and Romanticism in their symphonies; Schubert not infrequently revealed a characteristic Romantic penchant for intimate harmonic color and lyricism at the expense of close-knit formal structures.

A major part of the nineteenth-century symphonic activity went into the symphonic poem, but full-fledged symphonies continued to be written, although these were frequently programmatic. Among those that were not programmatic are the four great symphonies by Johannes Brahms, completed between 1876 and 1885, which go far toward reconciling the formal logic of Beethoven with the rich harmonic and melodic content of full Romanticism. Other enduring symphonies, all showing the influence of Classicism, are several by Mendelssohn and Schumann, written in the 1830's and 1840's; the programmatic *"Symphonie fantastique"* (1830) by Berlioz and the "Dante" (1856) and "Faust" (1857) symphonies by Liszt; the nine gigantic symphonies (1863-1894) by the devout and inspired mystic, Anton Bruckner, who often built up his initial ideas into full chorale-like themes; and a like number (1888-1909) by the impassioned and philosophical epicist, Gustav Mahler, who made extensive use of choruses and solo voices. Among the most popular symphonies composed more recently are César Franck's (the D-minor, 1888); Anton Dvořák's Fifth Symphony in E-minor, "From the New World" (1893); Tchaikovsky's Fourth in F-minor (1877), Fifth in E-minor (1888), and Sixth, or *"Pathétique,"* in B-minor (1893); Rachmaninoff's Second in E-minor (1907); and Sibelius' First in E-minor (1899), Second in D-major (1901), and Fifth in E-flat major (1915).

Among the contemporary composers who have convincingly demonstrated the continuing vitality of the symphony are Ralph Vaughan Williams, Paul Hindemith, Dimitri Shostakovich, Sergei Prokofiev, Igor Stravinsky, Roy Harris, and Aaron Copland. Notwithstanding the very different styles of these composers, their more recent symphonies are remarkably alike in their strong rhythmic vitality and in their efficient and compact terseness of expression. The old elements of the sonata form survive in these symphonies chiefly as general principles and seldom as structural details. W. S. N.

**SYMPLEGADES** [sɪmplɛ′gədiz], or the "Clashing Islands," in Greek legend, two islands or rocks at the north end of the Bosporus which crushed ships that passed between them. The Argo was the first vessel to sail through safely. G. E. D.

**SYNAGOGUE** [sɪ′nəgɒg], a Jewish house of worship. The term is derived from the Greek word *συναγωγή* ("assembly") and corresponds to the Hebrew word *ḳeneseth*. The Hebrew terms for synagogue are *bet ha-ḳeneseth* ("house of assembly") and *bet ha-tefilah* ("house of prayer"). The Yiddish word *shul* (from German *Schule*) and the term *temple* also commonly designate Jewish houses of worship: in popular American usage the former usually applies to Orthodox synagogues, the latter to Reform synagogues.

The date of the origin of the synagogue is uncertain, though it is highly probable that the institution was developed soon after the destruction of the First Temple (586 B.C.), and it is known that numerous synagogues existed in the period of the Second Temple (516 B.C.-A.D. 70). The synagogue has played an immensely important role in Jewish spiritual history. From its earliest days it served as a meeting house and a house of study as well as a house of prayer. In modern times many of the larger synagogues function as community centers, offering cultural, educational, and social, as well as religious facilities. A great number of synagogues conduct a *Talmud Torah,* or a religious school for children.

Since there is no prescribed architectural form for a synagogue, examples have varied from the simplest of buildings, or even a room in a building used for other purposes, to magnificent structures in a wide variety of architectural styles. On the inside, the essential furnishings are a platform (called *almemar* or *bimah*) and the holy ark in which the scrolls of the Torah (Pentateuch) are kept; other traditional furnishings are the perpetual light, a representation of the tables of the law (both over the holy ark), and two candelabra. In Orthodox synagogues men and women are seated apart, some synagogues having separate galleries for women.

Synagogues operate independently, and each congregation elects its own officers. The number of paid functionaries

generally include a rabbi who preaches and acts as spiritual leader of the congregation; a *hazzan,* or cantor, who leads the services; a reader, who reads from the scrolls of the law; and a *shammas* (*shammash*), or sexton, who supervises the building and fulfills a number of miscellaneous duties. The position of *hazzan* originally entailed numerous duties, but in the course of time these have been relegated to the *shammas* and other personnel, his sole remaining duty being to lead the prayers. On festivals the *hazzan* may be assisted by a male choir. Mixed choirs are found only in Reform (or advanced Conservative) temples, and it is only in these that organs or other musical instruments are played at services.

**Synagogue Council of America.** In the United States, the Orthodox, Conservative, and Reform synagogue groups have formed national synagogue associations. An over-all synagogue association is the Synagogue Council of America, founded in 1925, in which all the groups are represented and which concerns itself with problems regarding the entire American Jewish community.

**Great Synagogue.** The Great Synagogue (or Synod) was a legislative assembly which according to Jewish tradition functioned in Palestine between the fifth and third centuries B.C. Historical data on this subject are slight; it is not certain how long the assembly functioned and in fact some have doubted whether it existed at all. In the Book of Nehemiah there is an account of Nehemiah's convention of the elders of the community and this assembly presumably became the Great Synagogue; scholars have questioned, however, whether this group met for more than the one occasion or, if it did, whether it functioned for more than one generation.

Traditionally, however, the Men of the Great Synagogue (who supposedly included many of the Scribes) were the spiritual heirs of the prophets. There are a number of references to them in the Talmud and other Jewish writings, and they are credited with the establishment of certain religious institutions. *See also* Ark; Judaism (*Organized Judaism in America*); Perpetual Light; Rabbi; Scribes.

D. G. and G. W.

**SYNCHRONOUS CONVERTER.** *See* Converters.

**SYNCHRONOUS MACHINES.** *See* Alternating-Current Machines.

**SYNCHROSCOPE.** *See* Measurements, Electrical.

**SYNCHROTON.** *See* Electron and Ion Accelerators (*Synchronous Accelerators*).

**SYNCOPATION** [sɪŋkope′shən], in music, a disruption or contradiction of regular accents and rhythms. Since the end of the sixteenth century, Western music has been based on groups of two or three beats recurring regularly, the first of each group being accented, and whenever this regular pulse of beats and accents is "contradicted" by conflicting patterns, syncopation results. It may be partial, as in most jazz, wherein melodies are "syncopated" against a steady rhythmic background; or it may be complete, with all parts following the new pattern, which thus conflicts with the old pulse still "throbbing" in the listener's memory, as in the scherzo of Schumann's First Symphony, or in many parts of Stravinsky's *Rite of Spring.* W. Li.

**SYNCRETISM** [sɪ′ŋkrɪtɪzəm], in philosophy and religion, the attempt to combine elements taken from different systems of thought, e.g., the fusion of pagan religions by the identification of their gods. The term may be used with disapprobation when the divergent systems are irreconcilably opposed, so that the resulting combination is internally inconsistent or so superficial that the real difficulties are avoided. This was the case with the philosophical development from 200 B.C. to A.D. 250, when the Stoic, Peripatetic, and Platonic schools lost their original distinctiveness. The word is also used as a term of praise when the borrowings are harmonized and integrated by a dominating principle. In this sense it is applied to the work of Plotinus. The term also regularly refers to a movement in seventeenth-century Lutheranism that aimed to submerge the differences among Protestants and Roman Catholics. *See also* Eclecticism.

G. H. Cl.

**SYNDICALISM.** *See* Political Science and Philosophy (*Political Philosophy*).

**SYNGE, JOHN MILLINGTON** [sɪ′ŋ] (1871-1909), Irish dramatist, was born near Dublin on Apr. 16, 1871, and educated at Trinity College, Dublin. After leaving college, he studied music, abandoned it, and tried critical writing. In 1898 he met W. B. Yeats in Paris and received from him the suggestion to study the Irish of the Aran Islands and to write about them. Synge's subsequent work was largely based on the knowledge of the Irish folk that he gained by following this advice. In 1907 he published *The Aran Islands,* a journal and sketches.

JOHN MILLINGTON SYNGE

BROWN BROTHERS

Synge's first play, *In the Shadow of the Glen,* in one act, was produced in 1903 by the Irish National Theatre Society, headed by Yeats. *Riders to the Sea* followed in 1904, and *The Well of the Saints,* in three acts, in 1905. Synge became a director of the Abbey Theatre, along with Yeats and Lady Gregory in 1904.

*In the Shadow of the Glen* and *The Well of the Saints* had been somewhat criticized as irreverent or as misrepresenting the Irish. In 1907 Synge's *The Playboy of the Western World* was presented amid great disorder and Synge and his plays were thereafter for some years regarded with deep suspicion by many of the Irish; his *The Tinker's Wedding,* published in 1909, has never been performed by the Abbey company. Synge's last play, *Deirdre of the Sorrows,* was unfinished when he died in Dublin on Mar. 24, 1909, but in 1910 it was produced as he left it.

Synge's great achievement lay in the writing of an unusually musical and poetic dialogue, which in the mouths of his peasant or folklore characters creates a compelling and deeply moving effect. His humor, though occasionally ironic and bitter, is marked and at times even becomes boisterous. Though his parts are difficult to act, especially

by those not Irish, he has created highly individualized and memorable characters. *See also* PLAYBOY OF THE WESTERN WORLD, THE; RIDERS TO THE SEA. B. Pr.

**SYNOD** [sɪ′nəd], a gathering of ecclesiastical representatives, lawfully convoked, for discussion of and decision on Church matters. It is practically the equivalent of a council, and hence there may be said to be five kinds of synods. The first is ecumenical and is so recognized when the decisions of the synod have been approved by the whole Church; the second is general and may later become ecumenical, if and when its decisions receive universal acceptance; a national synod is a council of the chief ecclesiastics of a nation or country; a provincial synod is a council of the same kind in an ecclesiastical province; and a diocesan synod is the same thing in a diocese. The term *mixed synod* is sometimes used of a council of clergy and laity combined.

In the graduated system of the Presbyterian Church, a synod is the court next above the presbytery, but it is in turn lower than the general assembly. Similarly, in the Methodist Church, the synod is the meeting that functions between the circuits in the conference. In the Russian Church, until World War I, the supreme authority lay in the Holy Governing Synod. It had been created in 1721 by Peter the Great in order to transfer control of the Church from the Patriarch of Moscow to the Crown. While the Holy Synod was composed largely of ecclesiastics, its procurator was the personal representative of the tsar, and in this manner the Church in Russia lost most of its independence.

The term *Robber Synod* is applied in history to the synod which met at Ephesus in the year 449. It was a disorderly and turbulent assembly, and when the report of it was brought to Pope Leo the Great, he remarked that it evidently was not a lawful council at all but a *latrocinium,* or synod of robbers, and the name thus given has persisted through the ages. L. C. L.

**SYNODIC PERIOD** [sɪnɒd′dɪk]. The synodic period of a planet is the time interval between two successive similar aspects of a planet with the sun, as for example between two conjunctions or oppositions. In a synodic period, the faster moving planet gains one lap on the other. A planet's synodic period corresponds to the lunar synodic month, which is, for instance, the interval between two successive new moons. The synodic period of a planet thus differs from the sidereal period, which is the actual period of revolution around the sun with respect to the stars and not to the earth. The relation between the two periods is:

$$\frac{1}{\text{syn.}} = \pm\frac{1}{\text{sid.}} + \frac{1}{\text{sid.}_e},$$

in which syn. is the synodic period of the planet, sid. its sidereal period, and $\text{sid.}_e$ the sidereal period of the earth. The upper signs of the plus and minus symbols are for an inferior planet, and the lower signs are for a superior one. H. S. R.

**SYNTAX** [sɪ′ntæks], in linguistic science, the study of the way in which words are associated to form clauses or sentences. Morphology, the study of forms that indicate the relationship of words, is usually distinguished from syntax, but some scholars deny that any such distinction can be drawn. The difference between the two may be illustrated by an analogy from the game of chess, in which a study of the potential moves of every individual piece is comparable to morphology, while a study of the association of those moves—that is, of the strategy of the game—is comparable to syntax. According to B. Croce and the Neolinguists, however, any such distinction is unscientific because language is an inseparable unity. *See also* MORPHOLOGY; SENTENCE; SUBORDINATION. G. B.

**SYNTHETIC FIBERS,** a term used to describe man-made textile fibers, as distinguished from such naturally occurring fibers as cotton, linen, wool, or silk. Natural fibers have been used for many thousands of years for making ropes and for weaving or knitting fabrics. Beginning about 1890, however, and continuing with growing impetus, there has been a series of attempts by man to make his own fibers from natural and synthetic raw materials, and to control the processes of their manufacture so well that he may predetermine the nature of the product. The success of many of these attempts is attested by the magnitude of the synthetic-fiber industry and by the large number of domestic and industrial products made from rayon, nylon, and similar man-made filaments.

The term synthetic fibers, here applied to all man-made textile fibers, is sometimes used in a narrower sense to describe those filaments which have been completely synthesized from relatively simple chemical units; examples are nylon, dynel, Dacron, etc. These fibers will be referred to here as synthetic-base fibers. On the other hand, those man-made fibers which are formed from relatively complex chemical substances (e.g., cellulose or proteins) are frequently known as regenerated fibers; rayon is an example of this type of fiber. The principal commercial and experimental synthetic fibers are subdivided into regenerated and synthetic-base fibers.

REGENERATED FIBERS:

1. Cellulosic
   a. Viscose rayon
   b. Acetate
   c. Saponified acetate, e.g., Fortisan
   d. Cuprammonium rayon
2. Proteinaceous
   a. Zein (corn protein), e.g., Vicara
   b. Peanut protein, e.g., Ardil
   c. Casein
   d. Chicken-feather keratin
3. Alginate

SYNTHETIC-BASE FIBERS:

1. Acrylonitrile copolymers, e.g., dynel, Vinyon N, Acrilan, X-51
2. Glass, e.g., Fiberglas
3. Polyacrylonitrile, e.g., Orlon
4. Polyamide (nylon)
5. Polyester, e.g., Dacron, Terylene
6. Polyethylene
7. Polystyrene, e.g., Polyfibre
8. Polyvinyl alcohol
9. Vinyl chloride-vinyl acetate copolymer, e.g., Vinyon
10. Vinylidene chloride-vinyl chloride copolymer (saran)

**Characteristics.** In partial explanation of the motivation behind the development of synthetic fibers, it should be realized that each type of textile fiber, whether natural or synthetic, possesses certain physical and chemical characteristics which serve to distinguish it from all other types of fibers, and which recommend or contraindicate its use in any particular application. These properties, which are discussed at greater length in a later section, include both strong points and limitations: some fibers are very strong but brittle, others are weak but flexible; some can be stretched and will resume their original length, others can scarcely be extended at all without breaking; some can be dyed easily with many

types of coloring agents, whereas others are severely limited in the dyes which can be used. The major result of the development of synthetic fibers has been a vast increase in the range of materials from which man can make his cordage and textiles, and many new and useful combinations of properties. Thus, in many instances where a projected use requires a combination of properties not to be found in any existing natural fiber, a synthetic fiber can be "tailor-made" to serve the purpose.

**Distribution.** A second factor which has made the development of synthetic fibers of great importance is the relatively widespread distribution of their raw materials throughout the world, in contrast to more restricted distribution of areas for growing natural fibers. For example, although cotton and wool are grown in many countries, linen, silk, jute, and many other natural fibers are produced in only a few localities, and even cotton must be imported from great distances into some of the world's foremost textile centers. In special circumstances the chief sources of supply of important natural fibers may be cut off; for example, World War II saw the virtual denial of jute, abacá (Manila hemp), and silk imports to the United States and its allies, and synthetic fibers were called upon to perform many of the functions which previously had been in the domain of the natural materials.

## PHYSICAL AND CHEMICAL PROPERTIES OF FIBERS

Among the most obvious physical characteristics of a fiber are size (length and width) and density. The term width is used here in preference to diameter because the cross-section of most fibers is either highly irregular or somewhat oval, instead of round. It is important to know whether a fiber is produced in continuous lengths (as are most synthetic fibers), in relatively-short staple lengths (for example, Vicara), or in both, since this factor affects the manner in which the fiber will be handled in textile machinery as well as influencing the texture or "feel" of yarns and fabrics. Those synthetic fibers which are produced as continuous filaments are ordinarily twisted into yarns containing many of these filaments before leaving the factory, and may be used in weaving or knitting without further mechanical manipulation. Staple fibers, however, must be spun into yarns in a manner similar to that employed for cotton or wool. Yarns composed of continuous filaments are very smooth and may be extremely fine, whereas yarns made from synthetic staple fibers more closely resemble those spun from the natural products.

**Width.** The width of a fiber, which is usually so fine as to be measured in microns (1 micron = 0.00004 in.), may determine, in part, the type of fabric for which it is suited and the manner in which it must be fabricated. Fiber density, the weight per unit volume, not only influences the use to which a fiber may be put but is also employed as a component of a special measure of fiber fineness called denier. The denier of a fiber is defined as the weight in grams of 9,000 meters, and is dependent on both density and cross-sectional measurement. Denier measurements were originally applied to silk but are also commonly used to express the fineness of many synthetic fibers, among them rayon, nylon, and Vinyon. With reference to yarns made from filaments of synthetic fibers, such an expression as 60/20 indicates that the yarn is 60 denier and contains 20 filaments, each filament being approximately 3 denier. A similar unit for expressing yarn fineness is the grex, which is the weight in grams of 10,000 meters of yarn. In addition to these two systems, the older yarn numbering systems designed originally to apply to cotton, wool, and other natural fibers are sometimes used to describe the fineness of synthetic fibers, especially those produced in staple form. Thus, when cotton and rayon are to be blended in a yarn, the rayon-fiber fineness may be expressed in terms of the cotton count, in order to facilitate calculations in the spinning operation.

**Strength and Elasticity.** Probably the most important physical properties of fibers are strength and elasticity. Tensile strength, usually expressed in pounds per square inch, defines the load required to produce rupture of a given fiber. Fiber strength is sometimes reported as tenacity, a term that has acquired a somewhat specialized meaning in fiber technology. In referring to the strength of textile fibers, tenacity is usually expressed in grams per denier; these units cannot be equated with an expression of tensile strength in pounds per square inch unless the density of the fiber is taken into account. Among the synthetic fibers, nylon, glass, and saponified highly-stretched acetate rayon exhibit the highest tensile strengths.

*Elongation.* Ultimate elongation, a measure of the amount a fiber can be stretched before breaking, is customarily expressed in per cent of original length. Usually the extent to which a fiber can be elongated is less for fibers of high tensile strength, whereas low-strength fibers, such as the regenerated proteins, can sometimes be stretched to more than 50 per cent of their original length. Some types of fabrics are required to maintain their original dimensions under stress; for these, a high-strength low-elongation fiber would be chosen. In other cases, a fabric might be required to yield or stretch under a load without breaking; for this purpose, a fiber with a relatively-high ultimate elongation would be used.

*Elastic Recovery.* Elastic recovery refers to the ability of a fiber to recover from various types of deformation, such as extension, compression, and twisting. This property affects the utility of fibrous materials for a great many apparel and industrial purposes, since it is frequently necessary to produce a fabric that will regain its original dimensions and shape after distortion, as in such apparel as women's hosiery and men's suits.

*Stiffness and Toughness.* Among other properties of fibers of the same general category as strength and elasticity are stiffness and toughness. Stiffness is a measure of the resistance of the fiber to deformation; for example, it indicates how much effort must be expended to stretch a fiber a given amount. Stiffness is frequently expressed as the modulus of elasticity. Toughness is a measure of the work absorbed by the fiber while it is stressed to the point of rupture. The nylon used in making glider towropes is an example of a material exhibiting a high degree of toughness; it absorbs a relatively large amount of work before it breaks, for its high tensile strength enables it to withstand large loads and its high ultimate elongation permits large amounts of extension before rupture.

**Moisture Relations.** With the exception of a few synthetic-base fibers, all textile fibers tend to absorb water from a moist atmosphere and to release it as the atmosphere becomes drier. The amount of water held at a specified temperature and humidity, expressed as per cent of the dry fiber weight, is known as "moisture regain." ("Moisture regain" should not be confused with "moisture content" which, as applied to fibers, refers to the amount of water held expressed as a per cent of the total weight of fiber and moisture.) The moisture regain affects the suitability of fibers for many textile applications, as well as governing the conditions under which they may be fabricated. In addition, the absorp-

tion of moisture results in dimensional changes, most important of which is cross-sectional swelling.

**Electrical Properties.** Electrical properties of fibers are important when they are considered for use in condensers, or for insulation on electric wires and cables; the dielectric constant, power factor, and insulation resistance are frequently employed as dimensions of these properties. The retention of electrical charge resulting in "static" in textile fibers is an important consideration, especially in those fibers which absorb very little moisture, such as the synthetic-base fibers.

**Physical and Chemical Resistance.** In nearly all applications of fibrous products, their resistance to the effects of various physical and chemical agents must be considered. The most important of these agents are heat, sunlight, acids, alkalies, and miscellaneous chemicals and organic solvents such as those used in dry cleaning. Resistance to attack by moths and mildew must also be considered in many cases.

**Affinity for Dyes.** A further property of textile fibers is their ability to absorb dyes. The kinds of dyes which may be used vary according to the type of fiber and may influence its utilization for certain purposes, especially in apparel, upholstery, and similar applications. Fastness to light, washing, perspiration, and atmospheric gases depends primarily on the kind of dye used but is also influenced by the fiber to which the dye is applied. For many fibers, notably acetate rayon, special dyes and methods of application have been developed. Some fibers, such as saran, are colored by introducing a pigment into the spinning solution. A special instance of this process is the delustering of rayon by the addition of titanium dioxide to the spinning solution to give yarn with a dull, less reflective appearance.

Physical Properties of Synthetic Fibers

| Fiber | Length | | Width (*Microns*) | Density (*g./cc.*) | Tensile Strength | | Ultimate Elongation (% *at 65% Relative Humidity*) |
|---|---|---|---|---|---|---|---|
| | *Continuous* | *Staple (Inches)* | | | *Dry (Lb./Sq. In.)* | *Wet (% of Dry)* | |
| Viscose rayon* | Yes | 1-8 | 10-43 | 1.50-1.54 | 29,000-78,000 | 44-65 | 9-30 |
| Cuprammonium rayon | Yes | Experimental | About 11 | 1.54 | 33,000-42,000 | 59 | 10-17 |
| Acetate* | Yes | 15/16-7 | 11-46 | 1.30-1.35 | 18,000-30,000 | 50-75 | 23-50 |
| Saponified acetate | Yes | Experimental | About 10 | 1.52 | 138,000 | 85 | 6 |
| Protein, zein (Vicara) | No | 1/2-6 | 15-41 | 1.25 | 17,600-19,200 | 50 | 35-55 |
| Glass (Fiberglas) | Yes | Up to 18 | 5-10 | 2.54 | 250,000-315,000 | 99 | 2.5-3.15 |
| Polyamide (nylon)* | Yes | 1-5 | 10 upward | 1.14 | 65,000-117,000 | 85-90 | 14-25 |
| Vinyl resin (Vinyon)* | Yes | 1-5 | 16-18 | 1.33-1.36 | 10,000-76,000 | 100 | 10-35 |
| Vinylidene chloride (saran) | Yes | No | 50-1,300 | 1.68-1.75 | 25,000-60,000 | 100 | 20-30 |
| Polyacrylonitrile (Orlon) | Yes | No | 15-35 | 1.18 | 60,000-80,000 | 90-95 | 16-22 |
| Acrylonitrile-vinyl chloride (Vinyon N)* (dynel) | Yes | 1-9 | 8-42 | 1.31-1.32 | 51,000-70,000 | 100 | 12-35 |
| Polyethylene | Yes | No | 250-1,300 | 0.92 | 11,000-30,000 | 100 | 20-60 |
| Polyester (Dacron) | Yes | 1-5 | 10 upward | 1.38 | 68,000-118,000 | 100 | 22-48 |

Physical Properties of Synthetic Fibers (*Continued*)

| Fiber | Elastic Recovery† | | Moisture Regain (% *at 20°C., 65% Relative Humidity*) | Swelling in Water (% *Cross-sectional Area Increase*) | Effect of Heat | |
|---|---|---|---|---|---|---|
| | *Strain %* | *Recovery %* | | | *(Strength Loss Point, °F.)* | *(Softening Point, °F.)* |
| Viscose rayon* | 2<br>20 | 82<br>30 | 11.5–16.6 | 45–82 | \|\| | \|\| |
| Cuprammonium rayon | 5<br>15 | 48<br>32 | 11.0 | 99–134 | \|\| | \|\| |
| Acetate* | 2<br>20 | 94<br>23 | 6.3–6.5 | 18–26 | 194–225 | 397–406 |
| Saponified acetate | 2<br>5 | 82<br>67 | 10.0–11.5 | ..... | \|\| | \|\| |
| Protein, zein (Vicara) | 2<br>5 | 100<br>97.5 | 10 | 20 | 350 | 478–482 |
| Glass (Fiberglas) | 3 | 100 | 0 | 0 | No loss at 475; 50% loss at 685 | 1,380–1,550 |
| Polyamide (nylon)* | 2<br>20 | 100<br>75 | 3.5–4.0 | Slight | 284 | 482 |
| Vinyl resin (Vinyon)* | 2<br>20 | 99<br>63 | 0 | 0 | ..... | Melts at 260; Shrinks at 150 |
| Vinylidene chloride (saran) | ..... | ..... | 0 | 0 | 160–200 | 270–325; Shrinks at 160–250 |
| Polyacrylonitrile (Orlon) | 2<br>4 | 98<br>85 | 0.9 | Very slight | 300–350 | 455; sticks to copper block |
| Acrylonitrile-vinyl chloride (Vinyon N)* (dynel) | 3 | 93 | 0 | 4.3 | 160–275 | .... |
| Polyethylene | 5 | 95 | 0 | 0 | ..... | 5% shrinkage at 165; melts at 220 |
| Polyester (Dacron) | 2<br>8 | 97<br>80 | 0.4 | 0 | ..... | Sticks at 455; melts at 480 |

* Manufactured in different tenacities; data cover widest range.
† Data are not strictly comparable, since not all fibers were tested under identical conditions.
|| Not thermoplastic.

## COMPOSITION, MANUFACTURE, AND USES OF SYNTHETIC FIBERS

**Regenerated Fibers.** ***Viscose Rayon.*** Either bleached sulphite wood pulp or cotton linters, or a mixture of both, are used as the source of cellulose in the manufacture of viscose rayon. The cellulose is treated with sodium hydroxide to produce alkali cellulose, which is shredded into crumbs and allowed to age. The aged crumbs are churned with carbon disulphide, and the resulting compound, called cellulose xanthate, is converted into viscose by treatment with dilute sodium hydroxide. After filtering and maturing, the viscose is extruded through a spinneret into a coagulating bath, where the filaments are formed as regenerated cellulose. The yarn, composed of a group of filaments from a single spinneret twisted together, is then washed, desulphurized, bleached, and dried. The filaments can be cut into short lengths of staple fiber instead of being twisted into yarn. In the two oldest viscose-spinning methods, utilizing either the centrifugally operated Topham box or a perforated bobbin for winding the yarn from the spinning bath, subsequent operations such as twisting and washing must be performed separately. A newer system provides for a continuous process of spinning, washing, desulphurizing, and other necessary aftertreatments.

*Uses.* Viscose rayon is produced in greater volume than any other synthetic fiber. It is manufactured in a wide range of deniers and in three tenacities, the latter depending on the extent to which the yarn has been stretched during the spinning operation. Viscose rayon is used, either alone or blended with other fibers, in almost every type of apparel and household fabric, from hosiery and suitings to upholstery, draperies and rugs. Special high-strength viscose-rayon yarns are used for tire cords.

***Acetate.*** The first step in the manufacture of acetate is the acetylation of cellulose, in the form of purified cotton linters, to cellulose triacetate by treatment with acetic anhydride, glacial acetic acid, and a small amount of sulphuric acid as a catalyst. The cellulose triacetate, known as the primary acetate, must then be partially hydrolyzed to a secondary acetate with a somewhat lower acetyl content. The secondary acetate, in the form of flakes, is then washed, dried and dissolved in acetone, and the resulting solution is extruded through a spinneret into warm air. The highly volatile acetone is drawn off as vapor and the cellulose acetate filaments are ready to be twisted into yarn or cut into short lengths of staple fiber. Acetate may be modified by stretching and saponification to produce a regenerated cellulose fiber of unusual strength; Fortisan is an example.

*Uses.* Acetate is produced in several deniers and in two tenacities, regular and high-impact. In addition to its uses in lingerie and other light apparel, it has been extensively employed for electrical insulation by reason of its low moisture regain and excellent dielectric properties. Saponified acetate yarns, because of their unusually high strength and dimensional stability, have been utilized in military and industrial applications where such properties are of special importance.

***Cuprammonium Rayon.*** In the manufacture of cuprammonium rayon, purified cotton linters are mixed with cuprammonium solution, composed of basic copper sulphate and ammonia. The resulting viscous solution is formed into filaments by a stretch-spinning technique in which the solution is forced through a spinneret into a funnel containing deaerated, soft, running water. During passage through the funnel the filaments are stretched, and the ammonia and part of the copper are removed. Most of the remaining copper is removed in a coagulating bath containing dilute sulphuric acid, and the filaments, now combined to form a yarn, are wound into skeins. Any remaining acid and copper sulphate are washed from the skeins with water, and the yarn is left as practically pure regenerated cellulose.

*Uses.* Cuprammonium rayon, which is capable of being spun in extremely fine deniers, has been used mainly in hosiery, lingerie, and similar sheer garments.

***Nitrocellulose Rayon.*** The source of cellulose for the production of nitrocellulose rayon was purified cotton linters, which were treated with a mixture of concentrated nitric and sulphuric acids. The resulting viscous nitrocellulose was extruded through a spinneret and the filaments thus formed were hardened in a bath or air-dried in a special drying chamber. The next step was de-nitration of the filaments to reduce their flammability. The end product, as in the case of viscose and cuprammonium rayon, was a filament of nearly pure regenerated cellulose, though small percentages of nitrogen were sometimes present.

*Uses.* Nitrocellulose rayon was used primarily for apparel such as lingerie and blouses. The yarns were strong and could be produced in fine deniers, but the relatively high manufacturing cost, combined with the hazards involved in handling the raw materials, resulted in the gradual withdrawal of the product from the market. Nitrocellulose rayon has not been manufactured in the United States since 1935.

***Regenerated Protein Fibers.*** The first of the regenerated protein fibers to appear on the market was the Italian product Lanital, made from the milk protein casein according to a process developed by Ferretti from investigations begun in 1924. Another casein fiber, Aralac, was introduced in the United States in 1939. Production of this fiber ceased in 1948, being replaced by zein (corn protein) fiber, e.g., Vicara. More recently, pilot-plant production of protein-base fibers from peanut protein has been started, and experimental fibers have been made from egg albumin, soybeans, chicken-feather keratin, collagen, and other proteins.

The process for manufacturing synthetic protein fibers generally includes dissolving the protein in aqueous alkali, extruding the ripened spinning solution into an acid bath to form filaments, and subsequently treating these by various physical and chemical methods to give the finished fiber. The physical manipulations usually involve stretching, and sometimes steaming followed by stretching. Chemical treatments subsequent to acid precipitation usually include "hardening" or tanning reactions; the most common hardening agent used is formaldehyde. Aftertreatments, such as acetylation, are also used in some cases, such as in commercial casein fiber, to improve the resistance to boiling water.

*Uses.* Protein fiber has been used in blends with wool, cotton, rayon, and other fibers. Its dyeing properties and moisture relations approximate those of wool, and it imparts a wool-like feel to the fabrics in which it is employed. Its applications, usually in blends with other fibers, include suitings, coatings, sweaters, sportswear, and garment linings, and it has been widely used to blend with wool and rabbit hair in the manufacture of felt hats.

***Alginate Fibers.*** The newest members of the family of regenerated fibers, the alginates, stem from researches begun in England in 1937. Alginate fibers are derived from a constituent of seaweed called alginic acid and are produced by extruding an alkaline-earth metal alginate, into an acid bath. Properties of the filaments (such as resistance to aging or to alkalies) may be varied by changing the metal employed in the compound or by treating alginic acid yarn with basic acetates of chromium or beryllium.

*Uses.* A suggested use for alginate fibers is as "scaffolding" yarns for the production of novelty fabrics, where they would be used to support other types of filaments during weaving and would later be dissolved out of the fabric, leaving only a lacy structure composed entirely of the nonalginate filaments.

**Synthetic-base Fibers.** ***Nylon.*** The first commercial nylon yarn was produced in the latter part of 1939, although nylon bristles had been marketed a year earlier. This new substance was the culmination of 10 years of basic research, directed by W. H. Carothers in the laboratories of the E. I. duPont de Nemours Corporation.

Nylon is produced by the reaction of a diamine with a dicarboxylic acid to produce a polyamide chain. Since there are a great many diamines and dicarboxylic acids, the number of possible types of nylon is almost unlimited. The nylon produced commercially on the largest scale is polyhexamethylene adipamide, sometimes known as nylon 66. The hexamethylene diamine and adipic acid are combined to form a nylon salt, which is polymerized to polyhexamethylene adipamide, or nylon. This nylon, which may be cut into chips for storing or blending, is melted and extruded through a spinneret to form nylon filaments. The filaments are drawn out to about four times their original length, in order to provide the necessary tensile strength and elasticity. An elastic nylon, with properties approaching those of rubber, was developed in 1946.

*Uses.* In addition to the use of nylon for women's hosiery, which has absorbed the greater portion of its nonmilitary production, nylon has been employed in the manufacture of other garments such as lingerie, neckties, hats, and dresses. Its unusual tensile properties, combining high strength and good elasticity, have resulted in its use in ropes, parachute fabrics, and similar articles. Other applications of nylon include electrical insulation, tent fabrics, sewing thread, brush bristles, surgical sutures, and insect screening. More recently, nylon staple has been developed and is being used in blends with other fibers, where it contributes markedly to the strength and durability of the product.

***Vinyon.*** Vinyon yarn was first produced in 1939 from a synthetic resin. Vinyon is a copolymer resin of vinyl chloride and vinyl acetate. The resin is dissolved in acetone and spun in air through a spinneret, after which the acetone is recovered and the fibers are stretched. Vinyon N and dynel, more recent products, with improved dyeing properties and greater resistance to heat and organic solvents than regular Vinyon, are copolymers of vinyl chloride and acrylonitrile.

*Uses.* Because of its high resistance to the action of acids, alkalies, and other chemical agents, Vinyon has been used chiefly in the form of industrial filter cloths. Other applications include tent fabrics, awnings, marine cordage, chemically resistant hose, shoe fabrics, and upholstery.

***Saran.*** Development of vinylidene chloride began in the early 1930's, and commercial production of the thermoplastic resin saran, a vinylidene chloride-vinyl chloride copolymer, was announced in 1940. The vinylidene chloride and vinyl chloride are polymerized and the resulting copolymer is extruded into a die and stretched; the filaments thus produced are considerably larger in diameter than most other synthetic fibers. Saran is sold to producers of plastics and filaments, who may adopt other names for their products.

*Uses.* Saran is highly resistant to the action of light and of chemical agents, and has been used primarily in upholstery fabrics, special ropes, filter fabrics, screens, and handbags.

***Glass Fibers (Fiberglas).*** Commercial production of the only man-made inorganic textile fiber, Fiberglas, was begun in 1938. Glass filaments had been drawn to fairly fine diameters for many years and had been used for insulation and, occasionally, in novelty fabrics. Prior to the development of Fiberglas, however, the diameter was still too coarse to allow the flexibility necessary in most textile applications.

To produce Fiberglas, glass marbles, the chemical composition of which varies with the use intended for the end product, are melted in an electric furnace. The molten glass flows through a bushing containing many small orifices. If it is desired to manufacture a continuous filament, the streams emerging from the tiny holes are caught on a high-speed winding mechanism and drawn out to extremely fine diameters in continuous strands. Staple fibers of glass are made by subjecting the streams of molten glass emerging from the bushing to jets of high-pressure steam or air.

*Uses.* Because of its high tensile strength, electrical insulation resistance, noninflammability, and resistance to the action of most chemicals except alkalies, Fiberglas has been employed in a wide range of industrial applications. Masses of glass fibers are used for thermal and sound insulation, and for air filtration. Fabrics woven from Fiberglas are used for filtration of chemicals, electrical insulation, and for industrial textiles where resistance to high temperatures is required. In the domestic field, glass textiles have been used in draperies and novelty fabrics.

***Polyethylene Fibers.*** Polyethylene fibers were announced in 1944 as a result of the synthesis of straight-chain polymers from ethylene, a derivative of petroleum. Polyethylene resins are produced by direct polymerization of ethylene at high temperatures and pressures. The polymer is then melted, extruded through many fine holes, and drawn.

*Uses.* Polyethylene monofilaments (single large-diameter fibers) have been used in marine cordage, insect screening, and filter cloths, where their excellent resistance to attack by chemical agents is utilized. Experiments are continuing in an effort to develop polyethylene filaments suitable for additional applications.

***Polyester Fibers.*** Dacron is an example of a polyester fiber, a long-chain polymer resulting from the condensation of a dicarboxylic acid and a dihydroxy alcohol. In this case, the reaction takes place between terephthalic acid and ethylene glycol under high vacuum and high temperature in the absence of air. The resulting polymer is melted and spun at high temperatures.

*Uses.* Actually there are two varieties of this fiber which are produced. The high strength of the filament form is suggestive of uses similar to those of nylon. The staple form is better adapted to garments and is suggested for typical wool uses.

***Polystyrene Fiber.*** Polyfibre, announced in 1944, is a highly oriented fiber of unusually small diameter, produced by the polymerization of styrene to polystyrene. The fibers are not spun from a spinneret in the usual manner but are drawn from the molten polymer.

*Uses.* Polyfibre has been used primarily for low-temperature thermal insulation.

***Polyvinyl Alcohol Fibers.*** Development of polyvinyl alcohol fibers has been carried on since 1937. Polyvinyl alcohol is obtained by the hydrolysis of a polymerized vinyl compound, such as polyvinyl acetate, with an alcohol. The resulting compound may be rendered insoluble in hot and cold water and common organic solvents, if desired, by further reaction with a compound capable of forming a cross-linked structure between the chains of polyvinyl alcohol; one such substance is methacrylic acid monomer. Filaments may be spun from spinnerets in the usual manner.

*Uses.* Polyvinyl alcohol fibers have been suggested where solubility in water is advantageous, e.g., as an auxiliary yarn in knitting nylon hosiery and for surgical sutures.

***Polyacrylonitrile Fibers.*** Orlon is spun from a polymer of acrylonitrile. Other fibers are formed from copolymers of acrylonitrile and such substances as itaconic acid esters. Vinyon N is a copolymer of acrylonitrile and vinyl chloride.

*Uses.* The uses of polyacrylonitrile fibers are similar to those of Dacron.

**Blends.** There is a steadily growing trend towards the use of synthetic fibers, especially synthetic-base fibers, in blends with natural textile fibers. In this way, the advantages of both types of fiber may be exploited and the disadvantages, minimized. *See also* Cellulose; Plastics.

M. H. and R. E. W.

**SYNTHETIC RUBBER.** *See* Rubber.

**SYPHILIS.** *See* Venereal Diseases.

**SYRA.** *See* Síros.

**SYRACUSE** or **SIRACUSA** [sɪ′rəkyus, si′rɑku′zɑ], a province and the capital of that province, situated in southeastern Sicily.

**The City.** The main, and older, section of the city lies on Ortygia Island in the Ionian Sea, separated from the mainland by a narrow canal. The newer sections are found on the mainland. Syracuse's main harbor comprises a bay 3 mi. long and 1½ mi. wide, formed in large part by the peninsula and island on which the city is situated. A smaller port, accessible only to very small vessels, lies north of the island. The city is a popular tourist spot, and it is the focal point for excursions to the extensive ruins of the powerful ancient Greek metropolis of the same name lying mainly on the low plateau northwest of the modern city. These ruins include a Greek temple and theatre, sections of ancient fortifications and walls, aqueducts, a Roman amphitheatre, and catacombs. During World War II the city's populace used these catacombs as places of refuge. The ruins did not suffer any damage during the fighting and bombing raids prior to Syracuse's capture by British forces in July 1943, but the city itself was damaged, including a number of the historic monuments, notably the archaeological museum, the cathedral (the former Temple of Athena), and the Beneventano Palace. The Fountain of Arethusa, noted since Classical antiquity, is one of the city's most outstanding landmarks.

Syracuse flourished in ancient times, when it was Sicily's most powerful city and the center of Greek civilization on the island. It was first settled by settlers from Corinth in the eighth century B.C., and the city grew and prospered politically and commercially. The fifth century B.C. was marked by wars involving Athens and other Greek states in the Greek motherland. In the fourth century attacks by Carthage were rebuffed, but in the following century Syracuse joined the Carthaginians in the Second Punic War against Rome. In the famous Siege of Syracuse, which lasted for three years, Roman forces attacking by land and sea under the command of Marcellus finally captured and sacked the city in 212 B.C. Archimedes, the noted scientist who was a native of the city, was instrumental in prolonging the siege by devising various machines to repel the enemy. He employed beams swinging outward from the walls with heavy weights attached to crash down on the Roman ships. The story of Archimedes' attempts to burn the enemy fleet with huge reflectors is unlikely for there is no mention of its occurrence until the second century of the Christian Era.

*THE BATTLE OF SYRACUSE IN SEPTEMBER 413 B.C., A NAVAL ENGAGEMENT OF THE PELOPONNESIAN WAR IN WHICH THE BESIEGING ATHENIANS WERE DEFEATED AND THEIR FLEET WAS DESTROYED*

FROM AN OLD WOOD ENGRAVING

CULVER SERVICE

Under Roman rule Syracuse lost its importance, though it retained its status as the capital of Sicily. With the decline of Rome the city came under the control of the Vandals and Ostrogoths, and in 535 it fell to Byzantine armies under Belisarius. The Moslems, after repeated attacks, took the city in 878 and remained in control, save for two very brief intervals of Greek rule, until 1085, when the Normans conquered it. Thenceforth Syracuse generally shared the political history of Sicily. During the Napoleonic Wars its port was used by Lord Nelson in his blockade of the Italian peninsula. The Bourbon garrison of Syracuse surrendered to the liberating forces of Garibaldi on Sept. 3, 1860. Pop. (off. est. 1947), 64,584.

**The Province.** The province of Syracuse, encompassing 849 sq. mi., is Italy's southernmost province. In general the

terrain is low and flat along the coast with hilly country farther inland. The soil is fertile and produces large crops of cereals, fruits, olives, and vegetables. Over half the population works on the land. In addition to the capital, the other cities of consequence are Lentini, Avola, Noto, Pachino, Augusta, and Floridia. Pop. (off. est. 1947), 312,000.

R. G. W.

**SYRACUSE** [sɪ′rəkyus], a city in central New York, the county seat of Onondaga Co., about 75 mi. southeast of Rochester, on the New York State Barge Canal, near Onondaga Lake. The city lies on hilly ground overlooking the southern end of the lake in a rich farming region, near the Finger Lakes and Adirondack Mountains vacation areas.

The Syracuse region was the home of the Onondaga Indian Nation and the meeting place of the Five Nations of the Iroquois. When the Jesuit missionary Simon Le Moyne visited the city's site in 1654 he discovered that the springs which the Indians contended to be the home of evil spirits were salt springs. Ephraim Webster became the first permanent white settler of the city when he opened a trading post, which came to be known as Webster's Landing, in 1786. The original development and prosperity of the city of Syracuse was based on the exploitation of the numerous springs, and for nearly a century the district was the country's principal source of supply for salt. Asa Danforth and Comfort Tyler began commercial production in 1788. Salina and Geddes villages grew up around the salt works. Syracuse developed in the 1820's at the junction of great north-south and east-west valleys which placed it on the route of canals, turnpikes, railroads, and, later, airlines. Syracuse was incorporated as a village in 1825, and as a city in 1848. Absorbing the earlier villages, its commercial and industrial activity offset the transfer of salt manufacturing to rock salt centers. Nevertheless, present use of Syracuse area salt in chemical production in the vicinity greatly exceeds quantities formerly shipped from the city for table and dairy use. The city is the seat of Syracuse University and Le Moyne College. Syracuse has the mayor-council form of government.

Transportation is supplied by the New York Central and the Delaware, Lackawanna & Western railroads and the American and Colonial airlines. Syracuse's chief industries manufacture furniture, typewriters, farm implements, automobile gears and accessories, iron and steel products, electrical and electronics equipment, cans, pottery, air conditioning equipment, drugs, and clothing. Pop. 1950, 220,583.

L. J. O.

**SYRACUSE UNIVERSITY,** an accredited, coeducational, privately controlled institution (except for the New York State College of Forestry), founded and fostered by the Methodist Episcopal Church. The university occupies a 795-acre campus in Syracuse, N.Y. Syracuse University, chartered in 1870, absorbed Genesee College that was at Lima, N.Y., chartered in 1849. Instruction began at Syracuse in 1871. The numerous divisions of the university were founded as follows: College of Liberal Arts, 1871; College of Medicine, 1872 (a continuation of the Geneva College of Medicine, 1835-1872; incorporated into the State University of New York, 1950); College of Fine Arts, 1873; College of Law, 1895; L. C. Smith College of Applied Science, 1901; Summer Session, 1902; Teachers College, 1906 (became the School of Education, 1934); Library School, 1908; New York State College of Forestry at Syracuse University (founded by New York State, 1911; became part of the State University of New York, 1949); Graduate School, 1911; School of Speech and Dramatic Art, 1913; School of the University Hospital of the Good Shepherd, 1915 (became the School of Nursing, 1943); College of Home Economics, 1921 (established as a school, 1918); University College, 1918 (founded as the School of Extension Teaching and of Adult Education); College of Business Administration, 1920 (first established as a school, 1919); Maxwell Graduate School of Citizenship and Public Affairs, 1924; School of Journalism, 1934; Institute of Industrial Research, 1946; Utica College of Syracuse University, 1946.

Degrees offered include the A.B., B.S., B.E. in various engineering curricula, B.F.A., B.Mus., B.Arch., LL.B., B.L.S., M.A., Ed.D., M.S., M.D., and Ph.D. The D.D.S. emphasizes broad preparation as well as research in the social sciences. A new one-year program leads to the M.S. in radio and television. Army and Air Force R.O.T.C. units have been established; military training is optional and may be substituted for the physical education requirement.

The extensive library houses many special collections, some of which are Stephen Crane; Frederic Goudy; local and regional history; Methodism in New York; the Smallwood collection of natural history in the United States before 1875; Syracuse University archives; Wolfe-Leavenworth collection of portraits of early scientists; forestry library; Russian collection on history, economics, geography, literature; journalism library; library science collection; and French literature of the early nineteenth century.

Scholarship and fellowship aid is extremely generous, with some of it being set aside specifically for foreign students. Funds are available for loans, and opportunities for self-help enable many of the students to earn part or all of their expenses. Dormitories and fraternity and sorority houses provide living accommodations for men and women. *For statistics see* COLLEGES AND UNIVERSITIES.

J. R. To.

**SYR DARYA** [sɪ′r daryɑ′], the ancient Jaxartes, a river flowing principally through the Kazakh Soviet Socialist Republic of the Soviet Union. The Naryn, rising in the Petrov glacier of the Ak-shurak Hills, and the Kara Darya, rising in the snowfields of the Fergana Hills, in the Kirghiz S.S.R., join at Namangan to form the Syr Darya. The upper course of the Syr Darya flows from east to west, but near Leninabad the river turns north and then northwest, flowing into the Aral Sea at its northeastern extremity. In its 1,100-mi. length the Syr Darya flows through deep gorges with steep gradients in the east near the high Tien Shan, through a broad basin, the Fergana, in its middle course near Kokand, and through a desert, where the river constantly loses water in its course north of Tashkent. It enters the Aral Sea through a low marshy delta which is continually increasing. The river is at its widest in its middle course, where it averages a width of 400 ft. The tributaries of the Syr Darya are unimportant, with the exception of the Chirchik, which passes through the ancient town of Tashkent, the main center in the river's drainage basin. The Syr Darya has little value as a navigable waterway, since its mouth is blocked by a bar covered by only 3 ft. of water most of the time, and its middle course is broken by many sand bars. Extensive irrigation works have been built in the Fergana Basin in which cotton and melons are the chief crops.

J. E. V.

**SYRIA** [sɪ′rɪə], a republic located in the Near East. Confusion sometimes arises concerning it since Syria for centuries has been the name given to the geographical area between the Toros (Taurus) Mountains and the Sinai Peninsula and from the Mediterranean Sea eastward into the desert. Following World War I, when separate governments were established for Palestine and Transjordan, Syria usually

was the general name used to designate only the northern part of geographical Syria. After World War II, however, the two independent republics of Syria and Lebanon were established. Syria, therefore, is in modern usage the name of the state located approximately between 32° 25′ and 37° 25′ N. lat. and 35° 50′ and 42° 25′ E. long. It is bounded on the north and northeast by Turkey, on the east and southeast by Iraq, on the south by Jordan, and on the west by Israel, Lebanon, and the Mediterranean Sea. It covers a total area of about 72,000 sq. mi.

## GEOGRAPHICAL FEATURES

**Topography.** Much of Syria is plateau country. East of the Anti-Lebanon Mountains, which parallel the coast, are the plains of Aleppo, Hama, Homs, Damascus, and Hauran, with altitudes of 3,000 ft. or more. They fall off gradually to the north and east to the lowlands bordering the Euphrates River. The Euphrates rises in Turkey and flows southeastward for nearly 400 mi. through Syria before passing into Iraq. Its main Syrian tributary is the Nahr Khabour, which rises in Jezireh and waters much of the cultivated land of that province. The Orontes River flows northward through the plains of Homs and Hama but enters Turkey before emptying into the Mediterranean south of Antakya (Antioch). The south of Syria is a rugged, mountainous region still largely cut off from the main areas of the country. The province of Druz is located here, where the irregular topography has for centuries maintained the independent and local characteristics of the people and their society without significant change. The eastern sections of the provinces of Damascus, Homs, and Euphrates are called the Syrian Desert and this region merges with the Arabian Desert in Iraq and Transjordan to the south.

**Mineral Resources.** In Syria the known mineral resources are scanty and at present quite uneconomical to develop. Rumors of oil deposits in the provinces of Latakia, Euphrates, and Jezireh have circulated, and in 1949 an oil concession was granted to the Syrian-American Oil and Gas Company on the condition that three wildcat rigs be kept in operation continuously. Rich asphalt deposits exist in Latakia and along the Euphrates River and bitumen is found near Damascus. These as yet remain largely undeveloped. Excellent stone quarries are available in all of the provinces but the lack of transportation and their inefficient operation limit use of the stone to the immediate vicinity. Salt is extracted from numerous marshes throughout Syria and can be done in a manner to provide for an export market. Insignificant deposits of coal, iron, copper, lead, and gold have been discovered.

**Climate.** The climate of Syria is varied. Along the Mediterranean coast in Latakia, the winters are mild, with considerable rainfall, and the summers are dry though not excessively hot. In the interior, the plains of Aleppo, Hama, Homs, Damascus, and Hauran have cool, almost cold winters and hot, dry summer days with cool nights. Annual rainfall in this region averages between 10 and 20 in., but irrigation is a necessity since most of the rain falls in autumn and winter. Eastward, the plains merge into the Syrian Desert, where precipitation averages less than 2 in. a year.

**Soil.** About 50 per cent of the land is arable, but only half of the arable land is cultivated. Much of the land is exhausted from excessive use and lack of crop rotation. Water is scarce in most regions. In 1955 a five-year irrigation and farm-development program, eventually to cost $530,000,000, was begun, partially financed by a loan from the International Bank.

## ETHNOLOGY AND POPULATION

**Origins of the People.** Syrians are for the most part Semitic in origin. Throughout historic times and probably in prehistoric periods, Syria, the very center of the Fertile Crescent, has continuously received an influx of people from the eastern desert. Phoenicians, Canaanites, Hebrews, Aramaeans, and Arabs have inhabited various parts of Syria in the past, but the gradual infiltration of desert nomads, individually, by families, or even by whole tribes such as the Tanukhids, Ghassanids, and Taghlibids, has maintained the strong Semitic and Arabian character of the people.

**Language.** When the Aramaean state ruled from Damascus, the language of Syria and even of neighboring regions was Aramaean. Today Turkish and Kurdish are spoken in Jezireh, where a number of refugees from Turkey have settled since 1923. Another dialect, called Syriac, and the Greek tongue survive in Syria, but the language of the country and its people is primarily Arabic. Syrians contend that their Arabic is closer to the classical Arabic than any other form except possibly that spoken in Saudi Arabia.

**Religion.** About 85 per cent of the people of Syria are Moslems, and of these some 85 per cent are of the Sunnite sect. Christians form about 14 per cent of the population, and they are for the most part members of the Greek Orthodox and Armenian churches. Jews and others form less than one per cent of the population.

**Population.** The population of Syria is estimated to be about 3,568,000. At least 75 per cent of the people derive their livelihood from agriculture or from their herds. There are relatively few cities; their 1952 populations were: Aleppo, 380,919; Damascus, 372,708; Homs, 261,904; Hama, 155,671; and Latakia, 105,363.

## GOVERNMENT AND POLITICS

**Administration.** The country has in general followed the French type of republic, except to have a unicameral leg-

EWING GALLOWAY

*A tiny year-around stream waters the small town of Aadra which stands in the desert of southern Syria within the walls of an ancient caravanserai on the old Damascus-Cairo route.*

islature, the Chamber of Deputies, to which members are elected for a four-year term. The practice has been for an assembly to be elected by the people to draft a constitution. The president is the head of the state, and the cabinet, with a prime minister who acts as the executive, is chosen from the members of the Chamber. Theoretically, the president has a five-year term, but thus far no president has had a full term because of the numerous revolts.

**Civil Rights.** In 1949 the vote was extended to women, and more than 10,000 broke many of the traditions of the past and cast ballots for the Constituent Assembly in November of that year. Freedom of speech and the press have been greatly curtailed by the several *coups d'état.* Newspapers have been severely suppressed and various news items withheld.

**Political Parties.** The political parties of Syria are numerous; the strongest in the short history of the republic have been the Independents, the People's Party, the Nationalists, and the Resurrection Arab Socialists. The Communists, although active, have not been able to organize effectively. All parties are essentially nationalist, but they vary in the degree to which they wish to remain Syrian; some advocate a union with Jordan and Iraq to form a Greater Syria. All are hostile to Israel. Some prefer an alliance with Turkey and the West rather than a continuance in the exclusive Arab League.

**Finance.** Taxes in Syria are numerous. The most significant one for state and individual is the tithe which is collected from the produce of most lands. There are taxes on buildings, animals, land, and income as well as a general poll tax. There are many excise taxes and the usual import duties. From time to time, difficulties over the latter have arisen with Lebanon, for normally much of the Syrian external trade passes through Beirut and Tripoli.

**Government Enterprises.** Since water is so vital to the economy, the government has been most concerned with irrigation, which is almost entirely under government control. Various state power enterprises have been established, and early in 1950 a new project was started to harness the Yarmuk River. The government purchased one third of the stock in the company developing the port of Latakia and agreed to underwrite the whole enterprise. The Syrian government refused aid from the United States until 1954, has nationalized electricity, transport, and water, and is determined to use local capital in new developments and industries.

**Armed Forces.** The army, of about 40,000 men, is an important element in Syrian life and politics. All of the recent *coups d'état* were inspired and led by the army. The war in Palestine presented many problems. Although several divisions were deployed in northern Palestine, the Syrian armies were so ineffectual against the Israeli army that the military *coups* were reactions from foreign failure.

**International Relations.** The international position of Syria is exceedingly complex. A member of the Arab League, Syria was definitely opposed to the partition of Palestine and the establishment of Israel. Syria, however, has not been on easy relations with any of its neighbors. Financial and economic problems with Lebanon have led to the closing of that frontier on several occasions. Syria recognized the Arab government in Palestine at Gaza but considered Abdullah's annexation of Arab Palestine to Jordan as a threat to Syrian independence. Conversations with a view to creating a union with Iraq led to a *coup d'état* in 1949; the presence of many Armenians in Aleppo and refugee Turks and Kurds in Jezireh, as well as the award of the province of Alexandretta to Turkey in 1939, has caused much bitterness. Syria has been a member of the Security Council of the United Nations. Its somewhat anti-United States attitude was not the result of pro-Soviet or pro-Communist leanings but was related to the lead taken by the United States in promoting and recognizing Israel.

## ECONOMIC ACTIVITIES

**Agriculture.** In agriculture little fertilizer is used and the land is planted to wheat year after year. About 75 per cent of the cultivated acreage is given over to cereals, the principal ones being wheat, barley, oats, sorghum, corn, sesame, millet, and rice. Wheat, however, accounts for about two thirds of the total cereal production. Under the stimulus of high prices during and immediately after World War II and from the encouragement of the Middle East Supply Council in Cairo, swamp lands in Syria were drained, new areas in Jezireh were brought under cultivation, and new crops were introduced. Syria produces fine tobacco in Latakia, and a great increase has been made in cotton, potatoes, sugar cane, beans, peas, and lentils. In the environs of Damascus there are many apricot orchards, and sheets of dried pulp are a major item of Syrian export. Other agricultural products of importance are silk, olives, citrus fruits, figs, pistachio nuts, and grapes. Sheep and goats are raised abundantly, but very little cattle.

**Industry.** Industry for the most part is in the handicraft stage. In Aleppo, Damascus, Homs, and Hama handicrafts are important, and skill of a high order is attained by many of the artists and artisans. Weaving of cloth and rugs is the most important of these industries, and the finest of silk brocades are made in Syria. Damascus and Aleppo have always been noted for their excellent metalwork in brass, copper, silver, and iron. Only the silk-spinning industry has been organized on a factory basis. The government realizes the lack of many basic industries and plans to utilize local resources more fully. Progress has been made in the production of olive oil, cigarettes, dried fruits, rope, cement, and more recently, sugar and alcohol.

**Commerce.** Every village in Syria has its market, and the exchange of goods is an active and exciting experience. Local products make up the major part of the trade within Syria. The large trading cities are Aleppo, Damascus, Latakia, Homs, and Hama. Soap, olive oil, wheat and wheat flour, and cloth are the chief domestic products. Syria's imports are manufactured goods of every kind—metals, oils, gasoline, and similar products. Since a great deal of the country's trade passes through Lebanon, the port of Latakia is being developed to give more independence to Syria. Exports include cereals, olive oil, soap, animals, fruits, and tobacco. In the main, exports go to Palestine, Iraq, the United States, and France; the imports come from the United States, Great Britain, France, and Italy.

**Banking and Currency.** Until recently, banking in Syria was dominated by the Banque de Syrie et du Liban, which was a French bank with Paris headquarters. Since World War II, French influence has waned and local banks have grown in importance. Much of the banking and moneylending in Syria is controlled by Egyptian bankers. In 1948, when Syria divorced the pound from the franc bloc, Egyptian bankers visited Damascus to discuss and arrange for the exchange backing of the independent Syrian pound, the monetary unit established in common with Lebanon. In September 1955 it was worth approximately 25 cents in United States currency. The financial and economic position of Syria in the period following World War II has been rendered more difficult by the serious inflation that the war brought.

**Transportation.** In general, transportation remains in a backward condition. Damascus is connected by rail, through Lebanon, with Beirut, and then with Homs, Hama, and Aleppo, and by extensions with all the neighboring countries. Motor roads fan out from Damascus to the major cities and Palestine; the famous automobile road from Baghdad has its terminus in Damascus. Most transportation, however, is over poor wagon roads or caravan trails. In 1946 the Syrian Aviation Company began service between Damascus and Baghdad, Cairo, and Jidda. International airlines, such as Air France, KLM (Dutch), the Scandinavian, the British Overseas Aviation Corporation, and Pan American World Airways, have scheduled stops at Damascus.

## SOCIAL AND CULTURAL ACTIVITIES

**Education.** Education has not yet become available to all. Many Christian sects have their own schools and advanced institutions, so that frequently one finds only Moslems attending the public schools. There is an American school in Damascus and an American college in Aleppo, the latter being supported and operated by the American Board for Foreign Missions of the Congregational Church. Many children of the wealthier families study abroad. Elementary school is free and compulsory, but secondary schools are lacking. In 1947 an Institute of Technology was opened at Aleppo. There is a new Syrian State University at Damascus, specializing in law, pharmacy, medicine, and political science. However, 64 per cent of Syria's population is illiterate.

**Social Conditions.** In every aspect of the living conditions in Syria the standards are low. Fuel is scarce; consequently dung is frequently burned, depriving the fields of much needed fertilizers. Agricultural methods are outmoded and the yield is poor. Since the economy of Syria is almost entirely dependent upon this livelihood, the standard of living does not approach western standards. Nevertheless, there has been a rapid influx of western methods and ideas since 1940. Upper and middle class Syrians quite openly have adopted many Western ways. French and English are known, if not always spoken, by the educated classes. Many women in Damascus appear in mixed society no longer wearing the veil. As these changes continue, the customs and habits of the masses are affected.

EWING GALLOWAY

*Modern apartment houses and shops on a busy street in ancient Damascus, capital of Syria*

## HISTORY

Prior to the establishment of separate mandates for Palestine, Lebanon, and Syria following World War I, that part of the Fertile Crescent west of the Euphrates River had historically formed one political, economic, and geographic division, usually termed Syria.

**Early Peoples and Cultures.** In the earliest period of

history Syria was the land where the civilizations of Mesopotamia and the Nile met and were fused. Dominated usually by one or the other, the Syrians, a mixture of Mediterranean and alpine peoples speaking a Semitic tongue, assimilated and transformed these civilizations into one of their own. However, repeated waves of immigration, mainly from the eastern desert, maintained the Semitic character of Syrian civilization. Phoenicians, Canaanites, Aramaeans, and Hebrews migrated into Syria in the third and second millenniums B.C., and at different times created independent governments. The Phoenicians extended their commercial empire to embrace much of the Mediterranean area, the Aramaeans developed their trade overland to the Indian Ocean, and the Hebrews brought to the world a greater knowledge of God; but, ordinarily, ancient Syria was only a province in an empire ruled by Egyptians, Babylonians, Assyrians, Hittites, or Persians.

Following conquest by Alexander the Great in the fourth century B.C., Syria became a part of the Greek world under the Seleucid emperors and was Hellenized to such an extent that it rivaled Asia Minor and Alexandrian Egypt as a center of Greek culture. Toward the end of the Seleucid era such local principalities as the re-established Hebrew Kingdom and that of the Maccabees appeared. In the first century B.C., however, Syria fell to Rome, to remain under Roman and Byzantine rule until the advent of Islam. For seven hundred years Syria was an integral and influential part of the Mediterranean world, and Syrians were found in every part of the empire as merchants, generals, scholars, lawyers, poets, churchmen, and bureaucrats. At least two Syrians became Roman emperors. In the development and spread of Christianity Syria was important. Antioch and Edessa were centers where many Christian doctrines were formulated and where the Nestorian, Monophysite, and Monothelete sects began.

*The giant columns of the Temple of Jupiter are among the ruins of an ancient city which lies west of the modern town of Baalbek.*

PHILIP GENDREAU

Nevertheless, as the Mediterranean area became less unified, Syria entered a period of political and economic decline. In the third century A.D. the kingdom of Palmyra in the Syrian Desert appeared, but the strength of the empire was still sufficient to meet and crush this threat of desert nomads. Moreover, the administration from Constantinople grew exceedingly oppressive and decadent, and under the burden of Justinian's wars the economic situation intensified popular discontent. To this situation was added the Byzantine policy of persecuting the many Syrian sects not conforming with the Eastern Orthodox Church and of using Syria as a battleground when the neglected defenses of the empire invited a series of wars between the Sassanid and Byzantine empires.

**First Moslem Period.** Thus Islam met little local resistance in Syria. First invaded in 633, by 640 Syria had become a part of the Moslem Empire. However, the Arabization of Syria did not begin with the conquest, since desert nomads had been infiltrating the country for two thousand years. Conversion to Islam was slow and voluntary. Christians and Jews were definitely outside the Moslem community and did not enjoy full civil rights, but they were granted a greater degree of religious tolerance than had been enjoyed under Byzantine rule, and were allowed to keep their property and manage their own communities according to their ancient customs and laws. In less than a generation the wealth, industry, and size of the Syrian cities had shifted the center of the Moslem Empire from Mecca and Medina to Damascus. From 661, when Muawiyah, the governor of Syria, proclaimed himself caliph, until 750 Damascus was the seat of the Ommiad dynasty and the center of the Moslem world. The Ommiad Empire was administered by Syrians—Christian and Moslem alike—and its wars against the Byzantine emperors were waged by Syrian soldiers. Under the Ommiads, the caliphate remained wholly Arab and Moslem, and Arabic became the language of government in Syria, replacing Greek and Aramaic. However, the Hellenistic civilization of Syria prevailed, since the Arabs succumbed gradually to the culture, the social organization, and the political systems which they found. The Arabs "gained in technical mastery and maturity of the intellect; they lost the pristine simplicity of their faith and way of life."

Sectional, religious, and dynastic controversies in the eighth century shattered the glory of Damascus and Syria as the Abbasside caliphs established their chief residence in Baghdad. Syria's population decreased and its prosperity waned. During the subsequent three centuries of depression many changes occurred in the character and culture of Syria. Individual Christians and their communities found existence more difficult to endure; conversions to Islam were numerous, and the Arabic tongue became almost universal. Whole Christian communities were moved to mountainous regions for safety, especially during periods when weak caliphs ruled in Baghdad.

With the decay of the Abbasside government, Syria's north frontier became more vulnerable to Byzantine attacks. Along this uneasy line developed local principalities, Moslem and/or Christian in civilization, which looked to Baghdad or Constantinople for friendship, depending upon which was stronger or more generous in its subsidy. Heresy flourished and often was more popular than orthodoxy. Shiitism was popular and was the source of the extreme Alawite and Druse sects, which originated in this period. In addition, many movements were imported from Persia, Mesopotamia, and Egypt; these were built around various initiatory secret societies with revolutionary political, social, religious, and philosophical views.

The intellectual and emotional freedom which gave rise to this heterodox situation in northern Syria also created a condition that stimulated poets and authors. At the Hamdanid court at Aleppo, the philosopher al-Farabi (Alfarabius) composed psychological, political, and metaphysical works, and wrote treatises on Plato and Aristotle and books on medicine, mathematics, occult science, and music. He is considered the greatest music theorist among the Arabs. A contemporary at the Hamdanid court was the great Arab anthologist abu-al-Faraj al-Isfahani. His *Book of Songs* is called by the Arabs "the final resource of the student of belles-lettres." However, the two greatest cultural figures of this era in Syria were the poets abu-al-Ala al-Maarri and al-Mutanabbi. The former is particularly well known for his *Treatise on Forgiveness,* which some scholars assert influenced Dante in his composition of the *Divine Comedy,* and many quatrains of which had a strong influence upon the poetry of Omar Khayyām. Al-Mutanabbi was the poet laureate at the Hamdanid court at Aleppo, and his flowery style makes him still the most popular poet of the Arab world.

**Turkish Conquest.** This Syrian renaissance of the tenth and early eleventh centuries was ended rather abruptly with the conquest of Syria by the Seljuk Turks, who entered the country from Asia Minor and northern Mesopotamia. These invaders at first were a minor branch of the great Seljuk state in Persia, but, like their cousins at Konya, the Syrian Seljuks soon severed all outside allegiances and then split into two states, Damascus and Aleppo. The Seljuks, however, never penetrated into southern Syria, which remained under the control of such local families as the Tanukhids or recognized the suzerainty of the Egyptian Fatimids. At the end of the eleventh century this fragmentation of Syria was further complicated by the arrival of the Crusaders from western Europe, who ushered in a new epoch in the history of the Middle East.

**The Crusades.** In the last years of the eleventh century the Crusaders, mostly French, invaded Syria from Asia Minor and from the sea, conquering all of the coastal region and some of the interior. The feudal states of Edessa, Antioch, and Tripoli were organized by these European lords and knights, whose power and hold were maintained by a steady succession of reinforcements. Fully as important for the influence of Syria upon the west and for Syrian prosperity were the many Italian merchants and shippers who came with the Crusaders and established Frankish quarters in every coastal city of Syria, and in many of the cities of the interior. Sidon, Acre, Tyre, Aleppo, Antioch, Tripoli, Beirut, and many others came to have quarters inhabited by Pisans, Genoese, and other Italians, where vast quantities of pepper, sugar, and other eastern articles were gathered for shipment to western Europe. Crusaders who remained in Syria as long as five or ten years showed a marked tendency to mingle with the native population and to adopt much of their civilization. Subsequently most of the adaptations were transferred in one way or another to their western homes, and thus Syria played an important role in raising the cultural level of Europe. Syrian Christians were urged to submit to the papacy, a step which the Maronite Church took at this time. Moslems were treated with tolerance, although warfare between invader and inhabitant was intermittent from the first invasion in 1097 until 1291, when Acre, the last fortress of the Crusaders, fell.

Even at their best the crusaders never held more than a tenuous grasp on a narrow strip of Syrian coastland. The Moslem sway in Damascus was never threatened. When Zangi, the Turkish governor of Mosul, razed the city of Edessa, the Second Crusade was instigated, and in 1187 the fall of Jerusalem to the forces of the great Saladin precipitated the Third Crusade of Richard I of England, Philip Augustus, and Frederick Barbarossa of Germany. These and other crusades failed in their general purposes, leaving the remaining Crusaders in Syria to shift for themselves. Upon the death of Saladin, however, the Moslems were so divided that the remnant Christian principalities were able to hold on until 1291. In this period the Mongol invaders under Hulagu swept over Syria, massacring 50,000 at Aleppo and destroying many churches and mosques in Damascus. Stopped in 1260 by Baybars I, Mameluke sultan of Egypt, in a battle near the Palestinian coast, the Mongol horde retired to inner Asia, leaving Syria broken and depressed.

**Mameluke Rule.** Until 1516, Syria was ruled, except for brief interludes, by the Egyptian Mamelukes. This was a period of unrest, economic difficulties, population decline, poverty, and political and social decay. In the late thirteenth century the rebellion of the Druses and Shiites was ruthlessly suppressed by the Mamelukes, and in 1401 Aleppo and Damascus again were sacked, this time by Tamerlane, who carried off their artisans to his capital, Samarkand. The final blow to medieval life in Syria came from the Portuguese rounding of Africa, with its subsequent shifting of the trade routes between India and Europe to bypass the Middle East entirely. With the Syrian and Egyptian entrepots almost empty of oriental goods, political and economic chaos developed to such an extent that these areas fell easily and quickly in 1516-1517 to the Ottomans under Sultan Selim I.

**Ottoman Period.** For the next four hundred years Syria was a part of the Ottoman Empire. The first three centuries were, in general, periods of stagnation. The Turks divided the area at first into three provinces: Tripoli, Aleppo, and Damascus, the latter embracing all of the land south of that city to the borders of Egypt. Later, other provinces were created, such as those of Saida and Acre. Each of these provinces was governed by a pasha who was directly responsible to the government in Istanbul, so that Syria ceased to exist as a single state. The economic decline which had begun under the Mamelukes continued under the Ottomans, although taxes imposed by Turkey were less than formerly. Aleppo and Beirut became the main trading centers, and colonies of Europeans enjoying special privileges under the capitulations were established in many Syrian cities; most of the trade with Europe passed through their hands. In addition to these merchants, many missionaries, especially Roman Catholics—Franciscans and Jesuits—came to work among the Christians of Syria. They gave the area its first modern schools and were the first to succeed in bringing western ideas into the country to such a degree as to have a real influence upon Syrian society. However, since Syria did not attract Turkish settlers, the Turkish pashas frequently were unable to exercise any authority beyond the walls of the garrison city. This was especially true after the death of Suleiman the Magnificent in 1566, when power was held by Syrian feudal families, which ruled according to the ancient laws and customs of the land. Many of the families, such as the Maani and the Shihabi, were independent of the Ottoman government, except that formal respects were paid in the mosques to the sultan, who had taken the title caliph. Many of these families carried on feuds among themselves, and as a result of one of these conflicts the area southeast of Damascus called Jebel ed Druz was settled by a defeated Druse faction. At the end of this period much of Syria fell into the hands of Jazzar, pasha of Acre, who oppressed the people relentlessly until 1804.

Toward the end of the eighteenth century a radical influ-

ence began to permeate Syrian society. European powers, finding the Ottoman Empire only a shadow of its former glory, sought to establish spheres of influence. France cultivated the Maronites and other Catholics, the Russian tsars asserted the right of protection over Greek Orthodox Christians in Syria, and the British proffered their friendship to the Druses. Each of these powers thus interfered in the domestic affairs of Syria and each in its way aided in bringing European ideas of sovereignty to the Syrian people. The first great shock to the old order appeared to come in 1798-1799, when the French under Napoleon came to Egypt and marched up the Syrian coast. But, with the aid of the English fleet, Jazzar Pasha held Napoleon long enough at Acre to induce him to abandon the project and return to France. Thus, for the first three decades of the nineteenth century, the old order prevailed and rule from Constantinople was virtually nonexistent. Tax farmers, feudal lords, and predatory Bedouins made the life of the settled peasant almost unbearable, and the flow of commerce through the principal cities was the only evidence of prosperity.

In 1833, however, Mehemet Ali of Egypt compelled his nominal suzerain, the Ottoman sultan, to permit Syria's annexation to Egypt. The next six years under the rule of Ibrahim Pasha, Mehemet Ali's son or adopted son, began the modern era for Syria. Law and order prevailed, government schools were founded, and agriculture and trade were promoted. Ibrahim's government originally was popular, but the establishment of various state trade monopolies, heavy taxation, forced labor, and disarmament, as well as political and social discrimination against the important local families, led to considerable friction. The great powers of Europe came to look upon Mehemet Ali's proprietorship as a menace to their interests and were particularly irked by his commercial policies which discriminated against them. Thus, in 1839, when trouble arose between Turkey and Mehemet Ali, the great powers, except France, intervened to force Mehemet Ali to submit and evacuate Syria. This was done by diplomacy and by sending arms to the Druses and Maronites, who rose in revolt and drove Ibrahim back to Egypt. Nevertheless, a large portion of Ibrahim's accomplishment with respect to government, trade, agriculture, education, and westernization remained. Throughout the nineteenth century the great powers from time to time pressed the Turkish government to enact reforms of various kinds, but most of these were inadequately executed. The sultan, however, was strengthened by the creation of an army along European lines, so that the Ottoman government succeeded in curbing local feudalism in certain areas in northern Syria. Although the Pilgrims' Railway was built from Damascus to Medina, and other public works were begun under Abdul-Hamid II, Syria was far from prosperous and was very discontented. Many intellectuals subscribed to pan-Islamism and others to the Young Turks' Committee of Union and Progress, but after 1908 most Arabs realized that Arab interests were wholly disregarded and that Arab nationalist aspirations would only be served by their own political endeavors.

**World War I.** In 1914, when the Ottoman Empire entered World War I, negotiations were opened between the British and Grand Sherif Husein ibn-Ali of Mecca with regard to Arab participation in the war on the side of the Allies, on the basis that Arab independence would be recognized upon the successful termination of the war. Husein was promised that Syria, except for lands west of Damascus and Aleppo but including Palestine, would be held as an Arab independent state. In 1916, however, France and Great Britain signed the Sykes-Picot Agreement, which, in effect, gave the Syrian coastal area north of Acre to France, and the territory south of Acre and including Palestine and Transjordan to the British, leaving only the interior of north Syria to be independent. In 1917 the Balfour Declaration pledging British support for "the establishment in Palestine of a national home for the Jewish people," in addition to the Bolshevik disclosure of the Sykes-Picot arrangements, gave the Arabs considerable grounds for questioning Allied sincerity, although the British repeatedly in 1917 and 1918 promised recognition of Arab national existence and President Woodrow Wilson in his Fourteen Points held that the Arabs should be assured an "unmolested opportunity of autonomous development." In spite of Allied duplicity, the Arabs revolted against the Turks and aided materially in Marshal Allenby's capture of Damascus in 1918. Thereupon Syria was occupied by British, French, and Arab troops.

**Under French Mandate.** At the Paris Peace Conference violent disagreement arose over the disposition of Syria. President Wilson sent the King-Crane Commission to Syria to investigate, but its recommendation to create a Syrian independent constitutional monarchy under King Faisal, son of Husein ibn-Ali, was ignored. At the San Remo Conference, Syria was assigned to France as a mandate and Palestine and Transjordan were cut off and placed under British administration. Nevertheless, Faisal accepted the crown of Syria from a congress of notables meeting at Damascus in 1920 and, although agreeing to recognize the French mandate, he would not accept all the French demands. Thereupon French troops fought their way into Damascus, provoking the hatred of the Syrians. French rule in Syria began in an atmosphere charged with bitterness, suspicion, and resentment.

Under the mandate, a French high commissioner and a staff of French officials directed the policies of the state. In accordance with the terms of the mandate to France, organic laws were drafted for the establishment of local government, but Syria was divided into several states: Lebanon, Latakia (the Alawite state), Jebel ed Druz, and Syria. Latakia and Jebel ed Druz, however, were merged with Syria in 1936. Representative councils were chosen and a semblance of local government initiated. Unrest in Syria appeared almost immediately. High commissioners and administrators were changed too frequently, a Syrian federation was created and quickly dissolved, and the general instability of French policy led to forming the People's Party which advocated the independence of Syria and the union of the Arab world. In 1925 a rebellion occurred, first in Jebel ed Druz, and a sizable French force was defeated. The French quelled the outbreak in 1926, although Damascus was twice bombarded. As a result, Jebel ed Druz was placed under strict surveillance of a French governor, but Syria was permitted to elect a representative council. Ahmad Nami became the head of the first ministry.

In 1928 a constituent assembly was elected and the state of siege lifted. The assembly, under Hashim al-Atassi, drafted a constitution which proved unacceptable to France, and in 1930 the assembly was dissolved. France prepared a constitution for Syria, and in 1932 called for the election of a chamber of deputies, which, it was hoped, would arrange a Franco-Syrian treaty and the termination of the mandate. The treaty draft was placed before the chamber, but nationalist parties made acceptance impossible, so that the high commissioner dismissed the chamber and authorized the president to govern by decree. This situation prevailed until 1936, although Syrian discontent and national feeling grew apace. Early in 1936 a general strike occurred in Damascus

as a protest at the failure of France to grant Syrian independence. Leaders were invited to Paris to negotiate a Franco-Syrian treaty, which was signed Sept. 9, 1936. The treaty, allowing special privileges to France for twenty-five years, granted freedom whenever Syria was admitted to the League of Nations. A new Syrian chamber was elected, and Hashim al-Atassi was elected president of the republic. The treaty was approved and formally signed Dec. 22, 1936. Meanwhile, Latakia and Jebel ed Druz were annexed to Syria. The French government, however, failed to ratify the treaty, and this fact, together with concern over Palestine, the loss of Alexandretta to Turkey, and the administrative difficulties of the Syrian government, led to the collapse of this experiment of 1936. In 1939 the constitution of the republic was suspended, and the high commissioner appointed a provisional government.

**Syrian Independence.** Upon the outbreak of World War II in 1939, the country's prominent political figures declared their loyalty to France and the democracies, although most Syrians showed little interest. The capitulation of France to Germany in 1940 did not change the status of Syria until April 1941, when France withdrew from the League of Nations. Syria at this juncture considered the mandate as terminated, but no steps were taken to change the organic political structure until the occupation of Syria by British and Free French troops in July 1941 and the declaration of Syrian freedom and independence. Sheik Taj ad-Din al-Hasani, of Damascus, was recognized by the Free French as president of the Syrian republic, and in 1942 the British sent General Sir Edward Spears as British minister to the Syrian republic. General Spears controlled Syria until the end of World War II, since the French showed no desire either to transfer power to the Syrian government or to establish valid Syrian independence. Nevertheless, new elections were held in July 1943, the national bloc winning a decisive victory. Various difficulties with respect to finance, inflation, scarcity of goods, foreign trade, transportation of oil, irrigation, and administration confronted the new state. With full and complete recognition in 1944 by the United States and the U.S.S.R., Syrian independence was assured.

Since the formation in 1944 of the Arab League, Syria has taken an active part in its affairs. Syria is a member of the United Nations and has taken part in its deliberations. Syria served as a temporary member of the Security Council and the Committee on Trusteeship, and the Syrian delegate won respect by his skill in serving as chairman of the Council.

The partition of Palestine by the United Nations sharpened all of the problems confronting the Syrian republic and added new ones to trouble the leaders of the government. Although agreements had been made with the Iraq Petroleum Company and the Trans Arabian Pipeline Company for the right of transporting oil across Syria, the work of the latter was halted when the United States advocated the partition of Palestine. When fighting began in Palestine, tension mounted in Syria. The legations of France and the United States in Damascus were stoned and Communist Party headquarters was burned and the party outlawed. In December 1947 a draft was formally instituted and Druse offered to recruit 10,000 men for war in Palestine. The Syrian government, however, greatly irritated by the pronouncements of King Abdullah of Transjordan in calling for the establishment of a Greater Syria, countered with an invitation to Transjordan to rejoin the Syrian republic. In October 1948 it recognized the Arab government for Palestine at Gaza.

Unfortunately, Syrian politics have been very unstable. Already two constitutions have been drafted and adopted since 1945, and no president has served his legal term, not even Adeeb Shishekly, the strong man of Syria, who himself directed several *coups d'état.* The army overthrew most of the governments, but the Arab Suicide Redemption Falange was responsible for murders and assassination attempts between 1948 and 1950. The instability in government was partially due to intense national feelings that gripped the nation in relation to some of the issues. Military defeats by Israeli forces, trade and customs differences with Lebanon, reorientation of diplomatic policy toward the West and Turkey, have created dissension and strife. Nevertheless, after delays, in indication of protest, the world's biggest pipeline, extending from Saudi Arabia to Saida (1,069 mi.), was completed in 1950; the pipeline from Kirkuk oilfields in Iraq to Banias, 556 mi., was completed in 1952. After several years of bickering Jordan and Syria established diplomatic relations in 1951 and signed a friendship pact; a similar pact was signed with Iran in 1953; in 1955 Syria was invited to join the Turkey-Iraq friendship and defense pact. Even though Syria at one time refused aid under the United States Point Four Program, it applied for and received monetary aid from the International Bank in 1955, has received American military aid on several occasions, and in 1954, after an initial rebuff, accepted the United States plan and aid for the diversion of water from the Hule swamp area, with the purpose of developing electric power for Jordan, Israel, and Syria. S. N. F. and H. C. K.

**SYRIAC LITERATURE.** Syriac, originally the Aramaesic dialect spoken in Edessa, Northern Mesopotamia, whence Christianity spread over the whole of the Near East, became important only in connection with and in dependence upon the development of the Syrian Church. Most works composed in it deal, therefore, with religious subjects; their study belongs to church history and presents none or few features of artistic significance. With the earliest manifestations of Syriac literature, Greek influence was prominent, and many translations from the Greek were made of works dealing not only with religion but also with philosophy and science; many of these were later translated into Arabic, thus securing the survival of Greek thought during the Middle Ages. No interest was ever shown in the poetic achievements of the Greeks, although Theophilos of Edessa (died A.D. 785) translated Homer into Syriac.

Very little, indeed, was ever written in Syriac for the sake of entertainment. However, some Syrian authors were not devoid of a certain amount of artistry. *The Book of the Laws of the Countries,* a dialogue after Greek patterns, in which Bardesanes (c.154-c.223) refutes the tenets of the astrologers, is one of the earliest products of Syriac literature and contains some valuable passages. Bardesanes' son, Harmonios, composed hymns in which he expressed in poetry the gnostic system for which his father is held responsible, and in the scanty fragments that have survived we find real poetic inspiration. Another gnostic poem, *The Hymn of the Soul,* embodied in the apocryphal Acts of St. Thomas, is worthy of appreciation. The greatest personality in the ancient Syrian Church, St. Ephraem (c. 306-373) composed metrical hymns (*madrâshê* and *soghyâthâ*) and homilies (*mêmrê*) in order to counteract the impact of Harmonios' heretical poems upon the popular mind. The style and the meters (based on the number of syllables) introduced by St. Ephraem remained standard in later church literature; outstanding in this field were Isaac of Antioch (fifth century), of the Nestorian branch of the Syrian church, and Jacob of Serugh (sixth century), of the Jacobite branch, who was responsible, for instance, for a vivid descrip-

tion of the invasions of the Huns. Homily and theological polemics, generally in the form of epistles or short tracts, afforded some gifted authors the opportunity to develop an elegant and precise prose style: the best among them, especially for the vigor of his eloquence, is Philoxenus of Mabbogh (sixth century).

A historical novel, the *Romance of Julian the Apostate,* anonymously written about the same time, may be reckoned among belles-lettres, although its purpose is chiefly religious; two other outstanding literary products, more or less contemporary with *Julian,* are translations: the *Legend of Alexander the Great,* from the Greek; and the fable book known as *Kalilag and Damnag* (which became famous under the Arabic title *Kalîla and Dimna,* from the Pahlavi or Middle Persian, and ultimately from the Indian *Panchatantra*). Records of the deeds and acts of saints and especially of martyrs (those who suffered death under the Sassanid kings of Persia are particularly important) not only are valuable as historical documents but often are of considerable artistic achievement through the immediate appeal of their candid and unsophisticated style; this is also true of the early large collections of lives of monks and hermits, the most famous of which are the *History of Superiors* by Thomas of Marga and the *Book of Chastity* by Îshô'denah (both Nestorians, from the ninth century).

After the Arabian conquests in the seventh century, Syriac gradually ceased to be spoken, and Arabic took its place. Although Syriac continued to be used as a learned language, its estrangement from actual life proved fatal to the previous high aesthetic standard of literature. A short-lived rebirth in the thirteenth and fourteenth centuries was chiefly due to the personal action of two men, Bar-Hebraeus (1226-1286) in the Jacobite area and 'Abdîshô' (died 1318) in the Nestorian: both were entirely under the spell of Arabic culture; the latter, in order to show that Syriac was by no means inferior to Arabic as far as the richness of its vocabulary was concerned, vied with the refinements and niceties of Arabic rhymed prose in his *Paradise of Eden,* which is as admirable for its elaborate skill as it is poor in its artistic content. The report on a mission to the Pope and the King of France with which a dignitary of the Nestorian Church, Yahballâhâ, was entrusted by a Tatar sovereign at the end of the thirteenth century, is an amusing and skillful work. G. L. D. V.

**SYRIAN ARCHITECTURE,** in general, the architecture of Syria throughout all of its history. The term is used more specifically, however, to designate the monuments built in the Hellenistic, Roman, and Early Christian periods (third century B.C. to the seventh century of the Christian Era). No extensive Hellenistic remains survive prior to the Roman period (first century B.C. to the fourth century of the Christian Era), but Hellenistic influence pervades much of the provincial Roman work, and is present also in buildings constructed directly under imperial supervision, such as the great temple complex at Baalbek.

**Characteristics.** Several features, the result of the fusion of Hellenistic and native qualities, distinguish the architecture of the Hellenistic and Roman periods from contemporary work in other parts of the Mediterranean world. Stone is the chief material, basalt in the south and limestone in the north, and immense blocks, at times reaching sixty feet in length, are used throughout all parts of the buildings. In the north, where wood seems to have been plentiful, the post and lintel system supporting a wooden gable roof appears. In the south, however, where wood was scarcer, stone was used not only for roofing but also in many cases for the framework of doors and windows. To support the stone roofs, transverse arches springing from low, heavy piers were thrown across the rooms. The space between the crown of the arches and the side walls was filled up level with the crowns, and long slabs were laid from the side walls to the central line of support. In buildings of two or more stories the same method was used to carry the intervening floors. Lintels of doors and windows frequently had a semicircle cut in them above the opening which they spanned, producing what is called an arcuated lintel. Columns are usually unfluted, although fluted ones are found at Palmyra.

An outstanding characteristic, found on the façade of structures, is the arching of the entire entablature over the central intercolumniation which is wider than the others. This arching appears as early as the end of the first century B.C. in the temple of Dushara at Sî, and continues in use until the end of the Roman period. Examples may be seen in the west temple at 'Atîl (A.D. 151), the octagonal court at Baalbek (first and second centuries), and in the fragment of a Roman gate at Damascus. Two other typically Syrian features are the use of the niche as wall decoration, found at Palmyra, Jerash, Baalbek, 'Atîl, and elsewhere, and the development in the temple cella of an adytum (sanctuary) with a chamber on either side. Examples may be seen in southern Syria in the Tychaion at iṣ-Ṣanamên, the temple of Slêm, and the Serâyā and temple of Zeus at Ḳanawât.

**Carvings.** Rich carvings and moldings decorate the buildings of the pagan period, especially in southern Syria, in a style modeled on the Hellenistic. All three orders appear, the Corinthian most frequently. The acanthus leaf is usually the crisp, thorny *acanthus spinosus* of the Greeks, but the softer, rounded *acanthus mollis* of the Romans also appears. At Baalbek, both types are found side by side. Architraves commonly have a meander design, friezes are carved with scrolls of leaves and flowers, and pilasters carry rinceaux or arabesques in vine-leaf or acanthus patterns. The individual plants are naturalistically treated for the most part, but the design as a whole is conventionally arranged. At first the plant forms are handled plastically, but in the late second and third centuries the edges are more deeply undercut and an interest in contrasts of light and shade results. The coloristic manner so characteristic of later Byzantine work appears early in Syria.

**Secular Buildings.** Surviving ruins of cities and towns with temples, civic buildings, baths, inns, private dwellings of all kinds, and colonnaded streets attest the vigor and activity of Syrian builders during the Hellenistic and Roman eras.

**Religious Buildings.** No break exists between the pagan architecture and that of the Early Christian period (the fourth to seventh centuries). Churches take the place of temples, monastery construction begins in the fifth century and continues thereafter, and many of the varieties of secular buildings found in the previous ages are also to be found in the Christian cities and towns. The most extensive, and perhaps most interesting, remains of Early Christian architecture in Syria are the religious buildings, however, and the features they reveal are present also in the secular monuments.

The form of the churches is influenced by pagan antecedents. This influence is especially noticeable in the south, where both religious and civil monuments served as prototypes. Basalt was still the main material, and the transverse arch supporting a stone roof continued in use. In the north, closer to Hellenism, the most typical church type was the

three-aisled basilica with longitudinal supports, columns, and later piers, carrying architraves or arches. The building stone was limestone, laid dry, and the roofs were generally of wood, gabled and ending in a decorative pediment reminiscent of the Greek temple type.

**Ornamentation.** Ornament is the most distinguishing characteristic of Syrian Christian architecture. The northern monuments are more highly decorated than those of the south, where the interest in decoration decreased considerably from the fourth to the sixth century. In the north, in the fourth century, there was a marked reaction against Roman and Greek styles of ornament, and native forms were popular, such as ornamental and symbolic disks, cusped moldings around door frames, spiral terminations of window and door moldings, and geometric and foliate patterns treated in a flat, almost incised fashion with much stylization. In the sixth century, the reappearance of many Hellenistic and Roman motives gives the impression of a classic revival. Columns applied to the exterior walls, cornices with modillions or with dentils, molded string courses, details of capitals and friezes, all betray their pagan origin. These features may be seen in varying degree in the famous church of St. Simeon Stylites at Ḳal'at Sem'ân, at Ḳalb Lauzeh, at Dâr Ḳîtâ, and many other locations.

With the Arab and Moslem conquests in the early seventh century, Syrian architecture as a creative, vital force comes to an end. During its existence, however, it exercised a profound influence on Roman and Byzantine architecture.

J. M. H.

**SYRIAN DESERT.** *See* Arabian Desert.

**SYRINGA** [sɪrɪ′ŋgə], a name widely and erroneously given to the genus *Philadelphus,* shrubs of the saxifrage family. The proper common name of the genus is mock orange, for *Syringa* is the botanical name for lilac. About 40 species of *Philadelphus* are grown in the north temperate regions, mostly in the United States and Mexico. The shrubs are erect and vary in size from 6 ft. to occasionally 30 ft. or more; they have opposite simple leaves. The flower is usually white, and the supposed resemblance to an orange gives the shrub the common name mock orange. The best-known mock orange is the European *P. coronarius.* It has fragrant, cream-white flowers, and in a small way has escaped from cultivation and has naturalized itself in the eastern states.

Most of the species native to the United States, found in the South and on the West Coast, are without the fragrance of this European species, but some of the garden hybrids are extremely fragrant and have both single and double flowers. *See also* Lilac.

J. C. Wis.

**SYRINX** [sɪ′rɪŋks], in Greek mythology, a beautiful nymph beloved by Pan. She fled from him and, calling upon the nymphs for aid, was metamorphosed into a bed of reeds. Pan took reeds of unequal length from this bed and made from them the first Pan pipe, which he named syrinx in honor of the nymph.

G. E. D.

**SYROS.** *See* Siros.

**SYRTIS** [sɜ′rtɪs], two gulfs on the north coast of Africa, known in ancient times as Syrtis Major and Syrtis Minor, now known as the Gulf of Sidra and Gulf of Gabés.

G. E. D.

**SYZRAN** [sɪ′srəny], a commercial town in the Kuybyshev Region of the Russian Soviet Federated Socialist Republic, in the western Soviet Union, about 80 mi. west of Kuybyshev on the Syzran River, near the Volga. It originated in 1683 as a fort against the Tatars and Circassians and became an important center for grain trade. Later, numerous manufacturing plants sprang up in the town. Oil production began near by in 1937. Syzran is an important rail junction and has a port on the Volga. There is considerable transshipment of grain from the lower Volga for points to the northwest. Manufactures include leather goods, lumber, prepared foods, textiles, clothing, tobacco products, bricks, and distilled spirits. Pop. (est. 1950), 160,000.

C. C. H.

PHILIP GENDREAU

*The elaborate grillwork and carved arches of this ancient gateway at Beirut are excellent examples of Syrian architecture.*

**SZCZECIN** or **STETTIN** [shtshɛtsi′n, shteti′n], a Polish port city, in the former German province of Pomerania, located on both banks of the Oder River, about 285 mi. northwest of Warsaw, 80 mi. northeast of Berlin, 30 mi. from the Baltic Sea. Originally settled by Slavs, by the twelfth century the city was the largest in Pomerania, and from the twelfth to the seventeenth centuries it was the residence of the dukes of Pomerania; in 1360 it became a member of the Hanseatic League. The city was under Swedish control twice prior to its passing to Brandenburg in 1678 and finally to Prussia in 1720. Stettin, always a leading port and trade center, was the chief Baltic port for Berlin, with which it was connected by a ship canal. During World War II it was subjected to frequent and severe bombing raids in 1944 and 1945, and its harbor facilities and large shipyards were badly damaged. On Apr. 26, 1945, after a long siege and battle during which this important port was further devastated, the city was taken by Soviet forces. At the conclusion of the war Stettin was awarded to Poland, and its name was changed to Szczecin. Pop. 1946, 140,000.

S. D. M.

**SZÉCHENYI, COUNT ISTVAN** [se′tshɛnyɪ] (1791-1860), Hungarian statesman and writer, was born in Vienna, Sept. 21, 1791. Growing up in Vienna, he studied with Hungarian tutors. He fought through the Napoleonic wars, and between 1815 and 1822 traveled through western Europe, principally England, studying economic, social, and political conditions. He first attracted public notice by donating £5,000 for the creation of an Academy of Sciences in Hungary, in 1825, and he also founded a National Casino. In his first book, *A Hitel* (1830) ("Credit"), and *Stadium* (1833) he pointed out his country's ills—the feudal and antiquated farm system, stagnation in trade and com-

merce, lack of credit, backwardness of constitution. He demanded the elimination of serfdom and the abrogation of tax exemption of the nobility.

From 1830 to 1840 Széchenyi took the initiative in plans to make the Danube navigable, introducing the steamboat, and being instrumental in the building of roads, the bridging of the Danube, and the building of the National Theatre. He hoped to lift his nation out of economic and social backwardness and lead it toward independence. He was active in making proposals, criticizing others, and defending himself in numberless publications. Lajos Kossuth called him "the greatest Hungarian," but politically his liberalism was more and more outstripped by Kossuth's revolutionary spirit.

After the Revolution of 1848, Széchenyi became a member of the first responsible Hungarian Government, only to resign when an armed clash with Austria impended. He suffered a breakdown and was moved to a sanitarium at Döbling. When he regained his faculties in the early 1850's, his satirical articles against absolutism appeared often in Hungary under assumed names or were published abroad. Fearing to lose his reason, Széchenyi took his life on Apr. 8, 1860, in the asylum at Döbling near Vienna. His works on economic, financial, political and social subjects were republished collectively after his death. L. A. V.

**SZECHWAN** [sʌ′tshwɑ′n], a province in central China, on the upper reaches of the Yangtze River. It is bordered by Kansu and Shensi provinces on the north, Hupeh and Hunan provinces on the east, Kweichow and Yünnan provinces on the south, and Sikang Province on the west. Its area is 117,080 sq. mi. Chengtu is the provincial capital.

Szechwan was probably more Indian than Chinese in ancient times, but by the period of the Three Kingdoms (A.D. 220-589) it was thoroughly Chinese and was included in the Kingdom of Shu, by which name it is still sometimes called. It was divided into four *taos,* Chienan, Eastern Shanan, Western Shanan, and Chienchung, during the T'ang Dynasty (618-907), and into four routes, Yi, Tse, Lee, and Kwei, during the Sung Dynasty (960-1279.) It was made a province during the Mongol Dynasty (1279-1368). When the capital of China was moved to Chungking in Szechwan during World War II, the province became the economic and political center of China. Most of the inhabitants are Chinese of the Han race, although some Lolos and Miaos are found. The dialect is Upper Yangtze Mandarin, which is understood along most of the Yangtze River.

Szechwan extends more than 400 mi. east and west at its widest point and more than 300 mi. north and south. It is a red-sand basin, completely encircled by mountains that isolate the province to a great extent. The mountains to the west are a continuation of the Tibetan Plateau and include the 9,957 ft. Mount Omei, sacred to Buddhists. To the south and southwest are the Talow and Taliang *shan,* while to the north is the Mien Shan. The Ta Pa Shan extends along the northeastern and eastern borders of the province.

The Yangtze River enters the southwestern corner of the province and is fed by four tributaries before it leaves through the Yangtze Gorges to the east. The four tributaries, the Min, To, Pei, and Kialing, are the source of the province's name, Szechwan, which means "four streams." The Yangtze is the principal means of communication with the rest of China; there are no railroads, and the highways that were built during the war with Japan provide few outlets from the province. The Yangtze Gorges, formed by the river forcing its way through the Ta Pa Shan, begin near the city of Wan in Szechwan and continue toward the east for more than 200 mi. to Ichang in Hupeh. Junks and river steamers ply the turbulent waters of the gorges.

The Chengtu Plain, in the area of the provincial capital, is a subregion within the Red Basin, as the Szechwan basin is called. This compact plain, no more than 70 mi. from north to south and 50 mi. from east to west, comprises less than one thirtieth of the total area of Szechwan but nevertheless contains more than 10 per cent of the total population of the province. A rich growing area, it benefits from an irrigation system devised three centuries before Christ; the system involves dividing and redividing the waters of the Min River until the entire plain is irrigated.

Szechwan's climate is mild and moist. Along the Yangtze valley the summer temperature seldom goes as high as 100° F. while the winter temperature usually averages between 45° F. to 50° F. Snow and frost are rarely in evidence, except in the mountains, but heavy fog prevails from November until April, making the winters extremely humid and unpleasant. Annual precipitation in the province ranges from 35 in. in the north to 45 in. in the south.

Farmlands are found throughout Szechwan, and intense cultivation is practiced. Rice is the principal summer crop, wheat the principal winter crop. Other important agricultural products include sugar cane, tobacco, corn, and beans. Green tea is grown in the Chengtu Plain while silk is produced in Loshan, Santai, Langchung, and Hochuan. Over 10 per cent of the world's supply of hog bristles and large quantities of salt are produced in Szechwan. The salt brine is drawn from deep wells, some of which were drilled centuries ago by primitive methods. Insect wax, used chiefly to coat lacquerware, is a product gathered after a painstaking process of breeding and nurturing the wax-producing insects.

Szechwan, largest in area of the original provinces of China Proper, is the most populous province in all of China, despite its relatively inaccessible position. Its leading cities, in addition to Chengtu, the capital, are Chungking, wartime capital of China and counting more than a million inhabitants, Tzeliutsing, and Wan. Pop. 1947, 47,107,720. A. C. T.

**SZEGED** or **SZEGEDIN** [sɛ′gɛd, sɛ′gedin], second city of Hungary, situated at the confluence of the Tisza and Maros rivers in the southern part of the republic. Like other cities of the Great Alföld, Szeged is really a group of rural villages or peasant cities with a modern section built about the industrial center. Expansion was favored by the coming of the railroads and industries, the growth being reflected by a population increase from 32,000 in 1930 to 135,000 in 1930. The mills of Szeged, because of the great agricultural hinterland, are mostly concerned with agricultural processing, such as flour milling, distilling, beet-sugar refining, jam manufacturing, and paprika processing. Leather processing, ropemaking, and a few metalworking establishments complete the industrial make-up of this great market town. Szeged is the home port of Tisza fishermen and the greatest paprika market in the world. Pop. (off. est. 1948), 140,000. H. J. R.

**SZELL, GEORGE** [sɛl] (1897- ), Hungarian pianist and conductor, was born in Budapest on June 7, 1897. As a precocious youth, he excelled both as a pianist and composer, and before coming to the United States in 1940 he also conducted in Strasbourg, Prague, Düsseldorf, Berlin (1924-1930), and Glasgow (1937-1938) and toured Australia. Prior to his appointment as permanent conductor of the Cleveland orchestra in 1946, Szell appeared as guest conductor with many orchestras throughout the United States and also as pianist with chamber-music groups. E. L. F.

# T

**T**, *t*, the twentieth letter of the alphabet, was the last in ancient alphabets. The Egyptian hieroglyphic, which may have meant "mark," bore no resemblance to the early Semitic *taw* which did mean "mark" and is in its form suggestive of the modern sign used by illiterates in signing their name with x. Beginning with the early Semitic, the letter *T* has maintained its characteristic form, a slight modification of the right-angle cross, in all of the major alphabets. The Hebrew *taw* is less like its relatives but a faint family resemblance may be noted. The Greek *T* (*tau*) and the modern *T* are identical. In the Latin, cursive 𝒯 becomes in the Caroline style 𝒯, derived from the uncial 𝒯. The following table shows the few variations of the letter *T* from the earliest times. O. W. H-Q.

**Pronunciation.** *T* is in English, in most cases, a voiceless alveolar stop, which shares its mode of articulation with the stops *k* and *p*, and its place of articulation with *d*, *n*, and *l*. In initial position, especially before an accented vowel, English *t* is slightly aspirated, like Armenian *tʿ* or ancient Greek *θ*. This aspiration does not occur after *s*, so that the *t* of *top* is different from the *t* of *stop*. In English, however, this difference is purely phonetic, not phonemic, and the average speaker is unaware of its existence. In the United States, *t* between vowels, as in *pity, better,* and *at eight,* is very short and voiced and approaches *d*; in fact, the distinction between *latter* and *ladder* is one of quantity (duration) rather than quality. *T* is sometimes silent, as in *Matthew, mortgage, hautboy, chasten, listen, castle,* and *often,* but in *often* the "spelling pronunciation" is becoming more and more frequent, especially in emphatic speech. Combinations containing *t-* are usually pronounced as *č* (*ch*) in words of the type *question, actual, nature, righteous; ti* is pronounced as *š* (*sh*) in *patience, martial, nation,* and many other words of this kind. The pronunciation of *tt* is very much the same as that of *t*, but in words like *battle, throttle, shuttle,* and *little,* the sound is rather weak, being little more than a flip of the tongue.

The graphic combination *th* represents in English two entirely different sounds, neither of which had a symbol in the Latin alphabet. One of these is a voiceless, interdental fricative *θ*, usually found in initial or final position (as in *thin, thick, thorn; mouth, length, youth, cloth*); the other is a voiced, interdental fricative *ð*, found in initial position in many pronominal words (e.g., *that, this, then, them, the*) and between vowels (as in *gather, whether, bathing, clothing,* etc.). The occurrence of the voiced sound between vowels has produced a semantic differentiation in the pronunciation of the verb and of the noun in the following group of words: *cloth: to clothe; bath: to bathe; mouth: to mouth; loath: to loathe,* etc. The sign *th* is also pronounced as *t* in a few words, most of them foreign; among them are *thyme* (by Latin tradition), *phthisic, Thomas, Esther, Theresa,* and usually *Anthony* (where *h* is a purely graphic addition, not found in Latin *Antonius*). Conversely, in *authority, Martha, Catherine,* and in thousands of Greek words like *theater, orthography,* etc., *th* has assumed the pronunciation of *θ* by "spelling pronunciation"; in Latin, whence these words came into English, *th* was pronounced *t*. For voiceless *θ*, as in *thorn,* Middle English had a special sign *þ*, which was called "thorn," but this has now gone out of use.

Etymologically, in accordance with the formulations of Grimm's Law, an English *t* of Old English origin corresponds to a *d* in Latin, Greek, Slavic, Sanskrit, and other Indo-European languages (Eng. *ten, two;* Lat. *decem, duo;* Gr. δέκα, δύο; Russ. *djesjat, dva;* etc.). An English *d*, according to the same law, corresponds to a Latin *f*, Greek *θ*, and Sanskrit *dh*, all representing very probably an ancient Indo-European aspirated sound (Eng. *door,* Lat. *fores,* Ital. *fuori,*

| *Origin* | *Form* |
|---|---|
| *Egyptian Hieroglyphic and Cretan* | 𓏏 |
| *Semitic* | 𐤕 |
| *Phoenician* | 𐤕 |
| *Cypro-Phoenician* | 𐠕 |
| *Early Hebrew* | 𐤕 |
| *Greek Ninth Century B.C.* | T |
| *Greek Eighth Century B.C.* | T |
| *Crete* | T |
| *Greek Classical Capitals* | T |
| *Greek Classical Uncials* | T |
| *Etruscan* | T |
| *Latin Fourth Century B.C. Capitals* | T |
| *Latin Third Century A.D. Uncials* | 𝒯 |
| *Cyrillic* | T |
| *Russian* | T |
| *German* | 𝔗 |
| *English* | T |

Gr. θύρα). English *th*, in turn, corresponds to *t* in Latin, Greek, and other languages (Eng. *thin,* Lat. *tenuis,* Gr. ταν-ύς, etc.). In High German, in accordance with the consonant shift formulated in Grimm's Law, *t* became *ts* (Eng. *ten:* Ger. *zehn*); *d* became *t* (Eng. *door:* Ger. *Tür*); and *th* became *d* (Eng. *thin:* Ger. *dünn*).

Assibilation of *t* often occurs before an *i*, and even more before a *y*, *t* becoming either the affricate *ts* or (in a further stage) the sibilant *s*. Thus Latin *patientia, gratias* became *patsientsia, gratsias* in the third century of the Christian Era. This pronunciation was preserved in Italian (*pazienza,*

*grazia*); in Spanish *ts* became *θ* (*paciencia, gracia*); and in French *ts* became *s* (*patience, grâce;* whence English *patience, grace*).

Between vowels, *t* is apt, like all voiceless stops, to become voiced (as in English *pity*), to weaken progressively to a voiced fricative (*δ*), and even to disappear. This development is common to all the western Romance languages, including Portuguese, Spanish, Catalan, Provençal, French, Rhaeto-Romance, and Northern Italian. French has gone further than the others, for Latin *t* has entirely disappeared in words of direct tradition (Lat. *amata* > Fr. *aimée,* Lat. *pratum* > Fr. *pré*). Spanish is in the fricative stage (*chiflado, salado, prado,* with *d* pronounced *δ*), but pronunciations like *salao* are frequent among the lower classes. Provençal, Catalan, and Northern Italian are in the *d*-stage, their *t* being a voiced stop.

Some languages (Sicilian, Calabrese, Sanskrit) have also an "inverted," "retroflex," or "cacuminal" *t,* usually written *ṭ* by scholars, which is articulated farther back than the English *t*. The alveolar *t* is so characteristic of the English language that it marks the nationality of an English or American speaker whenever he pronounces it in a non-Germanic European language such as French.

*T* is the second most frequent letter of the English alphabet, averaging 95.9 per 1,000, immediately after *e,* which averages 123.1. It is far the most frequent consonant, the next being *n,* with 71.9. The letter *t* is used, however, alone and in the digraph *th,* to represent four different sounds: voiceless and voiced *t,* and voiceless and voiced *th*. G. B.

**TABARD INN,** the hostelry in Southwark, just across London bridge, where the pilgrims of Geoffrey Chaucer's *Canterbury Tales* spent the night before beginning their journey to Canterbury. The sign over the entrance was a short sleeveless coat with armorial bearings, then called a tabard. The host's name was Harry Bailey. In Chaucer's time there was in Southwark an actual inn with this name. R. K. R.

**TABER,** a town in Alberta, Canada, 32 mi. east of Lethbridge. It is the trade center for a rich irrigated agricultural and ranching area. Some oil is produced in the vicinity. The town is served by the Canadian Pacific Railway. Pop. 1951, 3,042. D. G. G. K.

**TABERNACLES, FEAST OF.** *See* SUKKOTH.

**TABLATURES** [tæ′blətshərz], old types of musical notation intended for use with certain specific instruments or families of instruments. They are all somewhat different from the normal notation used for most kinds of music. Tablatures are particularly characteristic of the fifteenth, sixteenth, and seventeenth centuries, although there are isolated examples in the fourteenth century. The most important kinds of tablatures were those for the organ, the clavichord, the harpsichord, and other keyboard instruments, and for instruments of the lute family. Of the keyboard tablatures, the German examples from the fifteenth and early sixteenth centuries are most characteristic. In these the highest part in the composition, corresponding to the soprano, is indicated in ordinary notation; the lower parts are indicated by letters written below the staff.

Lute tablatures began to appear in the early sixteenth century. German lute tablature, which had a short life, had a complicated system of letters and other symbols to refer to particular strings and frets on the instrument. The French, Italian, and Spanish systems were more practical. The lines, usually six in number, used in these tablatures do not constitute a staff but rather refer to the various strings of the lute, arranged in order from top to bottom. Letters or numbers placed upon a particular line refer to particular frets upon the corresponding string, or pair of strings, since most of the strings were doubled to increase sonority. Such a tablature thus provided the player with a clear picture of how he was to play the piece, but, on the other hand, the musical structure of the composition was not immediately apparent and could only be realized by translating the tablature into normal notation, as is done in modern editions of this music. Tablatures for ukulele and guitar came into use in the popular sheet music of the twentieth century. C. W. F.

**TABLE TENNIS,** an indoor adaptation of the game of lawn tennis, played on a table-sized court, with a small, very light, hollow celluloid ball and small wooden rackets or paddles. The exact origin of table tennis is not known, but the game became popular in England and the United States during the last part of the nineteenth century. Commercial interests in England and America popularized it under the trade name "Ping-pong," and during the first years of the twentieth century the game became sensationally popular, particularly in England. At that time, when a web-covered ball was used, the game was also called "whiff-whaff" and "gossima." The racket originally was a somewhat clumsy, paddle-shaped frame with a drumhead skin stretched tightly across it. When this racket was superseded about 1902 by the wooden paddle with stippled rubber face, and the celluloid ball was introduced, table tennis was greatly improved.

For a time table tennis waned in popularity, but after World War I there was a revival of interest in the game, and in 1926 the International Table Tennis Federation was organized. In the same year international team competition was inaugurated when Lady Swaythling of England donated the Swaythling Cup, which, like the Davis Cup in lawn tennis, has become emblematic of world team supremacy. The United States Table Tennis Association (U.S.T.T.A.) was organized in 1933 and is the governing body which establishes rules, sanctions tournaments, holds national championships, and fosters international play. Championships are held in men's and women's singles, men's and women's doubles and mixed doubles, boys' singles, and junior men's (ages 15 to 16) singles. Probably the best-known player to win the world championship singles title in table tennis was Fred Perry of England, who later won greater renown as a lawn-tennis player. Perry is said to attribute some of his skill in judging the spin of a ball in lawn tennis to his early training with the more highly reactive celluloid ball used in table tennis.

**Rules of the Game.** The game of table tennis is played on a firm, nonreflecting table, the surface of which is 2 ft. 6 in. off the floor. The table is 5 ft. wide by 9 ft. long and is divided into two equal courts for singles play by a net 6 ft. in length and 6 in. in height. The table must have a certain uniform resiliency as measured by the bounce (8 to 9 in.) of the regulation ball when dropped from a height of 12 in. There are no restrictions on the type or size of the racket. The ball, to be official, must meet certain size, weight, and quality specifications, in which case it bears the U.S.T.T.A. seal of approval.

Service in table tennis singles play is delivered by the same player until 5 successive points have been played, and no point is concluded until either the server or his opponent has scored a point. The ball must strike on the server's side

of the court before striking the top of the table on the opponent's court. Striking the ball before it bounces is not allowed. Unless the game goes to deuce (20 points each), the player first scoring 21 points is the winner of the game. If the game goes to deuce, the service thereafter changes with every point, and the winner is the player who first wins two points more than his opponent.

In doubles, the server serves for 5 successive points from his right-hand court into the right-hand court of the receiver, the table being divided by a line down the middle, parallel to the sides. Following receipt of service the partners alternate in playing until the point is decided. L. T. R.

**TABOO.** *See* PRIMITIVE RELIGION; TABOO, LINGUISTIC.

**TABOO, LINGUISTIC** [tăbu′], from Polynesian *tapu,* "sound," an interdiction of a religious kind, laid upon certain words and expressions. Akin to other forms of taboo which have flourished in primitive societies and are by no means extinct in advanced civilizations, linguistic taboo is a familiar phenomenon in both primitive and highly developed languages. The name *taboo* is also applied broadly in linguistics to interdictions of any kind, whether religious or not.

The mainspring of taboo is fear, especially the fear with which primitive, animistic man regarded the living universe that seemed to surround him. Not only were invisible gods present to his imagination, but he also saw in animals and in countless natural objects the habitations or even the actual shapes of spirits of all kinds. Identifying the name with the thing named, as in primitive magic, he sought to avoid the attention of these unpredictable and frequently dangerous beings by not naming them, or by naming them in a devious way.

A characteristic manifestation of taboo, which can be observed in innumerable languages, is the treatment of the name "God." As the result of religious interdiction, such as that embodied in the Third Commandment, "Thou shalt not take the name of the Lord thy God in vain," this name in many languages is either replaced by another or transformed. Thus, Hebrew *Jahve* is read *Adonai.* Greek had ὁ Κύριος as a substitute for ὁ θεός, and Latin had *Dominus* for *Deus,* a substitution that became universal in Romanian. In English *the Lord* is frequently substituted for *God; the Saviour, the Redeemer,* or *Christ,* for *Jesus; the Virgin* for *Mary.* In Italian, *il Signore, Domineddio,* and *la Madonna* are similarly used. Sometimes, as in *le bon Dieu* or *merciful God!,* the name is transformed simply by the addition of a new element.

The names of harmful deities are more frequently taboo than the name of God. For example, mention of the devil, which in medieval legend evoked the devil himself, is still avoided by many. The Greek Furies, whose proper name was Ἐρινύες (Erinyes), were frequently called Εὐμενίδες (Eumenides, "the benevolent ones") by way of appeasement. Another typical taboo name is Latin *Di manes,* "the good gods," which was applied to the baleful spirits of the dead, who were believed to return to earth as ghosts, vampires, and other terrifying shapes. The *flamen Dialis,* the chief priest of ancient Rome, was not allowed to pronounce the names of objects in several categories, corpses being one of them, and in many primitive tribes it is forbidden to mention the names of the dead.

Taboo applies, in primitive society, also to the names of certain wild animals which are harmful or dangerous to man. Thus, the name of the bear, preserved in Greek (ἄρκτος), Latin (*ursus*), and Vedic (*ṛkṣas*), has been interdicted in Germanic and Slavic, Germanic substituting a word that meant "the brown one" (Eng. *bear,* Ger. *Bär,* etc.), and Slavic substituting "the honey-eater" (*medvedi*). The transparency of these periphrases shows that the substitution was recent, for the more recent a word formation is, the clearer it is. The wolf was called *hircus,* "billy-goat," by the Sabines in ancient times; the jaguar and the boa constrictor are in one primitive area designated by substitute names at night, when they are considered most dangerous; and the eagle is called *Adler* by the Germans, probably because taboo has dictated the substitution of *edler Aar,* "noble eagle," for the simple name *Aar.* Interdictions of the names of animals are very rare, however, in modern society.

A somewhat more unexpected taboo seems to have applied in primitive society to the names of the hand, the finger, and the hair of the human body. In general, the names of other parts of the body are among the most constant elements in language, as may be seen in the following Indo-European words: Eng. *knee,* Lat. *genu,* Gr. γόνυ; Eng. *nose,* Lat. *nasus,* Russ. *nos;* Eng. *tooth,* Lat. *dens,* Gr. ὀδούς. The Indo-European names for "hand," "finger," and "hair," however, cannot be satisfactorily reconstructed, and if this void could not be explained by the operation of taboo, one would be tempted to conclude that the Indo-Europeans were handless, fingerless, and hairless. Presumably the hand and fingers of an adversary were recognized as potentially dangerous, and the many religious customs that involve cutting of the hair suggest that the hair also has been regarded as possessing some power to harm. This taboo, however, ceased to operate thousands of years ago, for in more recent times it can be seen that the names involved have been rather constant. Thus, among the Romance languages, there has been no substitution in French *doigt, main, cheveux,* Italian dito, mano, *capelli,* or Spanish *dedo, mano, cabellos;* and the same is true of the Germanic languages, English having *finger, hand, hair,* which correspond to German *Finger, Hand, Haar.*

A very common form of taboo in all modern languages is the deformation of religious names when these are used as exclamations or curses. French has *sapristi* for *sang Cristi, parbleu* or *pardi* for *par Dieu,* and *morbleu* for *mort de Dieu;* Italian has *cribbio* for *Cristo* and *la Madosca* for *la Madonna;* and English has an enormous and formidable variety, including *gosh, golly, heck, holy smoke, 's wounds, Judas priest, jiminy cricket,* etc. A simple substitution, such as *the Redeemer* for *Christ,* would be inappropriate here, for it would in no way diminish the offense to the deity, and therefore, in these cases, the taboo finds expression only in deformation.

The word *taboo* is also frequently applied, rather loosely, to certain other linguistic interdictions that are closely related psychologically to taboo proper but might better be called superstitions. These, like taboo, are caused by fear, perhaps even by fear of a supernatural power, but they are not exactly religious or animistic in nature. One such superstition forbids mention of names of ill omen. For example, the ancient Persians called the Black Sea aχšaēna-, "blue," but ἄξεινος, the Greek rendering of this name, meant "inhospitable," an ominous epithet indeed for an unknown northern sea; accordingly the Greeks substituted the name Πόντος Εὔξεινος, with the opposite meaning of "hospitable sea," and this the Romans adopted as a normal name (*Pontus Euxinus*). Similarly, the Italian city of Benevento had, before the Roman conquest, the Illyrian name *Maleuentum.* In Illyrian, *mal-* meant "hill," but in Latin it meant "bad," and to avoid suggesting that "bad fortune" attended the place, the Romans substituted *ben-,* the opposite of *mal-.* The linguistic process in both of these instances is known as euphemism. It is

similar, but not identical, to the one by which the Furies became known as *the Eumenides.*

A similar interdiction, also due to superstition, has eliminated the words meaning "to kill" and "to die" in many languages, replacing them with other words or with periphrases. For *to die,* for example, English has *to depart, to pass away, to go west, to kick the bucket,* etc., and Italian has *tirare la calzetta, dare gli ultimi,* and many more. Whereas, in the Romance languages, the Latin word for "to live" is preserved intact everywhere (e.g., Fr. *vivre,* Ital. *vivere,* Sp. *vivir*), the words for *to kill* (Lat. *interficio, occido*) have changed in almost every region (e.g., Fr. *tuer;* Ital. *ammazzare, accoppare;* Sp. *matar, dar el paseo*). The same contrast may be observed in the Germanic languages also, English *to live* being German *leben,* and English *to kill* being represented in German by the totally unrelated *töten.* It is significant in this connection that it has been impossible to reconstruct the Indo-European name of any disease, or even the name of "disease" itself.

In addition to interdictions that have their roots in religion or superstition, there are many others, of a social character, which are only distantly related to taboo. Among the innumerable classes of words affected by such interdictions may be mentioned certain European names for relatives "in law" (eg., Fr. *beau-fils, belle mère,* Sp. *padre político*) and, in many languages, the names of certain physiological functions and all that is associated with them (e.g., Eng. *rest room, smoking room;* Ger. *der Abort,* "the place apart"; Ital. *il luogo,* "the place").

From the formal point of view, a particular taboo can operate in any one or more than one of the following ways:

1. By deformation, as *heck* for *hell.*
2. By replacement, as "the honey-eater" for "the bear."
3. By the addition of a new element to the old, as *le bon Dieu* for *Dieu.*
4. By the use of an adjective drawn from the name instead of the name itself, as Greek ἥλιος, "the solar (one)," instead of **swēl,* "the sun."
5. By resort to a foreign word, as English *inferno* (an Italian word) as a substitute for *hell.* G. B.

**TABRIZ** [təbri′z], the capital and chief city of Azerbaijan, the northwestern province of Iran, situated about 60 mi. south of the Soviet border and about 110 mi. east of Turkey. The city is 4,600 ft. above sea level on a plain north of Sahand Mountain (12,105 ft.), and is flanked on the north by a brick-red range of hills on the Aji Chai or Bitter River. Located in an earthquake area, the city was almost completely destroyed by severe shocks in A.D. 858, 1041, and 1721, and has suffered from time to time from minor quakes.

Tabriz became important in early times because of its position on the great trade routes to the Black Sea and the Russian Caucasus region. An important road leads from Iraq through the Ruwandiz Gorge in the mountains along the western boundary of Iran. At the close of the thirteenth century, Tabriz was made a capital by Ghazan Khan, the Mongol ruler of an empire extending from central Asia to Egypt. His tomb, in a western suburb, is today only a mound of crushed brick and broken tile. In the early fourteenth century, the city became a great educational center, when Rashīd al-Dīn, a prime minister, who was also a noted physician and historian, founded in the suburb of Rashidiyeh an astronomical observatory, a hospital, numerous schools, and an extensive group of religious buildings, which attracted scholars and educators from many parts of the world. This center was destroyed when its founder fell from power in 1318. His rival, Taj-id-Dīn Ali Shah, built a great mosque (1312-1322), one of the most massive brick structures in the world, whose ruins became the ark or citadel of the city. Tamerlane captured Tabriz and, at the beginning of the fifteenth century, made it the capital of a vast province of his empire. Shah Jahan of the so-called Black Sheep Dynasty established his capital at Tabriz in 1436 and built the famous Blue Mosque, long known as the Turquoise of Islam, of which some tile faïence remains. In the sixteenth century, Tabriz became the capital of Shah Ismail, founder of the Safawid Dynasty, who later moved the seat of his government southeast to the less exposed city of Kazvin. Tabriz was taken by the Turks and Russians on numerous occasions but has continued to be the most important city of western Iran. Early in the twentieth century the people of Tabriz played a prominent part in the movement for constitutional government in Iran. At the time of World War I, the Russians built a railroad from Dzhulfa to Tabriz; a branch line leads to Sharifkhaneh, on the northern shore of Lake Urmia, where boats make connections with other points on the lake. For a time after World War II, Tabriz was the capital of the abortive movement for an independent state of Azerbaijan.

Tabriz is a center of rug weaving and has recently developed plants for the manufacture of leather, cotton thread, matches, and other products. A concrete grain elevator of large proportions has been built by the government. At one time there were 28 mi. of covered streets to house the bazaars, with their shops and numerous hand industries. An American mission hospital and church are located in Tabriz, but the schools formerly maintained by the American Presbyterian mission have been taken over by the government, and a university has been established. The city suffered recently from the opening of other trade routes; industry has not developed rapidly enough to maintain a rise in population; and many people have emigrated. Tabriz has an airfield and a large barracks. Pop. 1944, 213,542. J. C. Wi.

**TABULATING EQUIPMENT.** *See* Business Machines and Equipment.

**TACAMAHAC** [tæ′kəməhæk], Indian name for the balsam poplar, *Populus tacamahaca,* native to northern North America from New England to North Dakota and Alaska. The tree is much planted in the north for wind protection and ornament. It grows as high as 90 ft. W. D. B.

**TACANA.** *See* Indian Tribes, South American (*Other Linguistic Groups and Tribes*).

**TACAZZE** [takaze′], an important river, about 450 mi. long, draining the mountainous north of Ethiopia. From its source near the peak of Guna (13,881 ft.), it flows north and west into the Atbara River, in east Sudan, which flows into the Nile. The central section of the Tacazze has worn an imposing canyon, which separates the province of Tigre from the mountains of the Semien north of Lake Tana. The lower reaches of the Tacazze form part of the boundary between Ethiopia and Eritrea. This section of it, known as the Setit River, often becomes a shallow stream in the dry season. R. G. W.

**TACHOMETER** [təkɒ′mɪtər], from two Greek words meaning "speed" and "measure," an instrument ordinarily used to measure the speed of rotation of a shaft. It is usually calibrated in revolutions per minute (r.p.m.). If the instrument is of the rotating type, it may also be adapted to measure linear, or surface, speeds.

From the standpoint of use, tachometers may be classified as hand (portable) types and as stationary types. From the viewpoint of operating principles they may be classified as (1) mechanical, (2) electric, (3) vibrating-reed, (4) stroboscopic. In all except the last, a mechanical connection is required to the device the r.p.m. of which is to be measured. This connection will be permanent or momentary, depending on the use of the tachometer. In the mechanical and electric types, connection is made to the rotating shaft, whereas the vibrating-reed type is either rigidly mounted on the frame of the machine or held by hand against the frame. In the stroboscopic type, the connection is through a beam of light.

**Mechanical.** The mechanical type may make use of the centrifugal or flyball governor principle. Fig. 1 shows the operating features of such a tachometer. One end of the shaft *A* is connected to the shaft the speed of which is to be measured. The other end of *A* is connected to the centrifugal governor *W* through a set of change gears, in order to provide several ranges on the instrument. Rotation of the weights *W* about the axis *C* imparts longitudinal displacement to the rod *R*. This, in turn, moves the pointer *P* to a position dependent on the r.p.m. of shaft *A* and restraining action of the spring *S*. A scale under the pointer is calibrated in r.p.m.

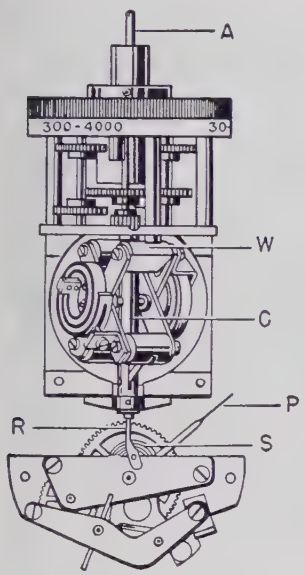



*Fig. 1—OPERATING MECHANISM OF A CENTRIFUGAL-TYPE TACHOMETER*

COURTESY OF JAMES G. BIDDLE CO.

In a hand type of mechanical tachometer, the connection between the tachometer shaft and that of the machine, the r.p.m. of which is to be measured, is usually established by pressing a cone-shaped rubber tip on the former into the centerhole of the latter. In using such an instrument, it is important to hold it parallel to the shaft of the machine the speed of which is being measured.

Another mechanical type is shown in Fig. 2. This is sometimes called the chronometric tachometer, or speed indicator. It is not an instantaneous-reading type. Fig. 3 shows the scheme of operation. The shaft *A* rotates in contact with the shaft the speed of which is desired. Upon pressing the starting button shown in Fig. 2, the wheel *B* attached to the pointer is allowed to rotate for exactly 6 sec., after which it comes to rest. The timing mechanism and its escapement, shown in the lower part of Fig. 3, are regulated to release wheel *B* at point *C* for exactly 6 sec. The dial is then calibrated in r.p.m., and in Fig. 2 the speed indicated is 1,430 r.p.m. This type, therefore, gives the average speed for 6 sec. It can also be used to measure average surface speeds in feet per minute.

**Electric.** The electric tachometer usually employs some type of electric generator, the shaft of which is connected to the shaft the speed of which is to be measured. This connection may be direct, or through gears or pulleys if necessary to provide suitable generator speeds. The generator may be either d.-c. or a.-c., but is usually of the permanent-magnet type. In the a.-c. type, the permanent-magnet structure rotates so that the voltage is produced in stationary coils. In the d.-c. type, the armature conductors are placed in slots and connected to a commutator, which usually is made of a silver alloy. The brushes are also of silver alloy, to reduce contact resistance, and are self-lubricated to provide long wear. The voltage produced at the terminal of the magneto is directly proportional to the r.p.m., and is measured by a suitable voltmeter attached to the terminals. The scale on the voltmeter is calibrated in r.p.m. The voltmeter sensitivity, in ohms per volt, must be suitable for the type of magneto used; a high-resistance voltmeter is preferred. The voltage produced is around 6 volts per 1,000 r.p.m. The most satisfactory speeds for the d.-c. magneto are from 500 to 2,000 r.p.m. If other speeds are to be measured, gear or pulley reducers may be required.

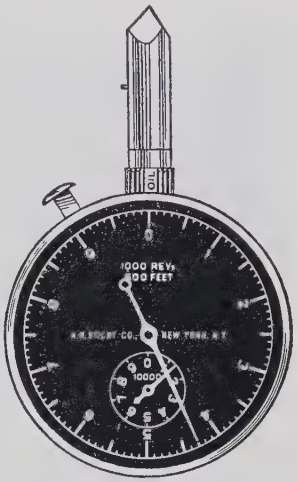



*Fig. 2—A CHRONOMETRIC TACHOMETER RECORDING A SHAFT SPEED OF 1430 R.P.M.*

COURTESY OF HERMAN H. STICHT CO.

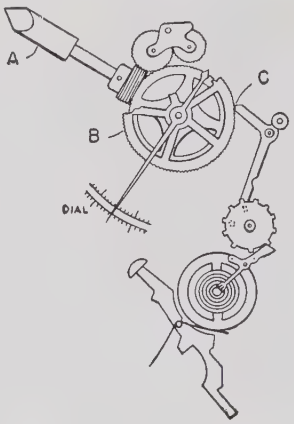
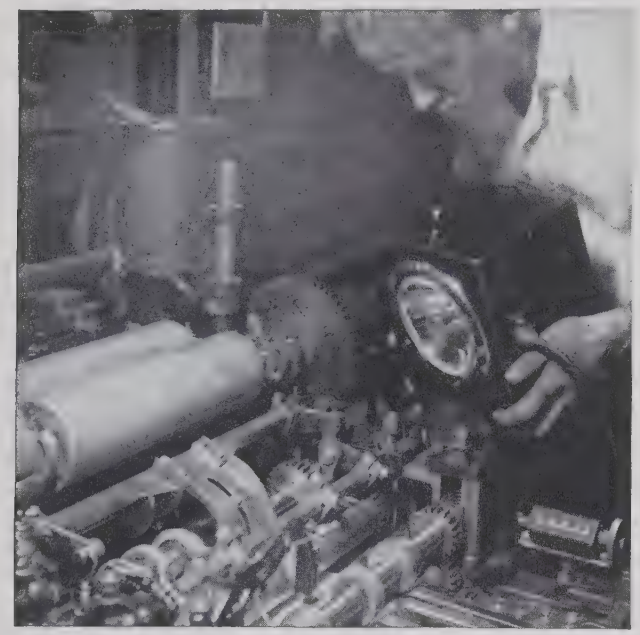



*Fig. 3—OPERATING MECHANISM OF A CHRONOMETRIC TACHOMETER*

COURTESY OF JAMES G. BIDDLE CO.

*Magnetic-Drag (Aircraft) Type.* There is also a magnetic-drag type of tachometer, used in aircraft. In this type, the generator is three-phase, with rotating permanent magnets. The output is fed to a magnetic indicator having a three-phase stator winding. The rotor of the indicator consists of a permanent magnet structure and hysteresis disk mounted

on the shaft. The torque on the indicator rotor is developed by the reaction between the rotating field of the stator windings and the permanent magnets and hysteresis disk on the rotor. The speed of this rotor is synchronous with that of the generator. The indicator element has a rotating magnet assembly, coupled to the shaft of the indicator rotor. This consists of two circular plates on each of which are mounted an equal number of small permanent magnets arranged to face each other but separated by a small air gap. A thin aluminum



COURTESY OF GENERAL RADIO CO.

*Method of using a stroboscopic tachometer to measure shaft speed of rotation*

alloy drag disk is located in this air gap. The torque on this disk is proportioned to the speed of the rotating magnetic assembly, and the motion of this disk is restrained by a calibrated spring. The scale under the pointer is calibrated in r.p.m.

With the a.-c. generator and synchronous motor omitted, this drag-type indicator is used in automobiles to indicate speed in miles per hour. In this application, the rotating-magnet assembly is mechanically connected to the driveshaft by means of a flexible shaft.

*Metron.* Another type of electric tachometer is marketed under the trade name Metron. This tachometer is based on the electrical principle that the average charging current of a capacitor is proportional to the frequency at which the polarity of the voltage across its terminal is reversed. The source of voltage is a constant d.-c. voltage, which may be obtained from a flashlight battery. The tachometer head contains a reversing switch only, to provide means for varying the frequency of reversal at the capacitor in direct proportion to the speed to be measured. The circuit is so arranged that the pulsating current through the milliameter is unidirectional, and hence this meter is a sensitive d.-c. permanent-magnet type and registers the average charging current of the capacitor. The circuit constants are adjusted so that the accuracy is not dependent on the contact time or contact resistance, and the scale of the meter is calibrated in r.p.m. This type of tachometer requires less power from the rotating shaft, whose speed is being measured, than the electric tachometer previously described.

**Vibrating-Reed.** The vibrating-reed type consists of several steel reeds, each of which is tuned to vibrate at a different resonant frequency. A small rectangular indicator painted white is mounted on the end of each reed. The instrument is mounted on the frame of the machine the speed of which is desired. These instruments are available in a variety of ranges between 900 and 60,000 r.p.m., with a maximum range of about 2 to 1 in any single-scale instrument.

**Stroboscopic.** The stroboscopic tachometer employs a marked rotating disk or sector mounted on the shaft the speed of which is to be measured. This disk is illuminated by a flashing high-intensity source of light. The frequency of the flashing is controlled by electronic means and is adjustable. The duration of each single flash is of the order of a few millionths of a second. The rotating marked disk will appear stationary if the speed of the flashing light is adjusted to the speed of the disk. The dial controlling this speed of flashing may be calibrated in r.p.m. This type of tachometer is especially useful at high speed. C. C. Wh.

**TACITUS, CORNELIUS** [tæ′sɪtəs] (c. A.D. 55-c.117), Roman historian, served as praetor in 88, became consul suffectus in 97, and governed the province of Asia as proconsul in 112-113. Five works of Tacitus have descended to us: the *Dialogus de oratoribus,* a concise dialogue on the decline of oratory; the *Agricola* (*De vita et moribus Iulii Agricolae*), a brief biography of his father-in-law, Gnaeus Julius Agricola, sometime governor of Britain; the *Germania* (*De origine situ moribus ac populis Germanorum*), a short essay of prime importance as our best source of information about the ancient Germans; the *Historiae,* a narrative of the principates of Galba, Otho, Vitellius, Vespasian, Titus, and Domitian (A.D. 51-96); and the *Annales* (*Ab excessu divi augusti*), an account of the reigns of Tiberius, Caligula, Claudius, and Nero (A.D. 14-68).

Because of its style, which differs markedly from that of his other writings, the *Dialogus* was assailed for more than four centuries as unauthentic, but by the beginning of the twentieth century the tide of criticism had turned and Tacitus' claim to its authorship has since achieved common acceptance. The date of composition of this treatise is uncertain, but the difference in style had induced most investigators to infer an early date for its composition and thus to assign it to the reign of Titus (79-81). The *Agricola,* which is commonly considered the *chef d'oeuvre* of Roman biography, is not, however, limited to biographical considerations, but extends its discussion broadly to the climate, geography, and ethnology of Britain as well as to the conquest of that island by Rome. Furthermore, while it is a professed panegyric, it is also a diatribe against Domitian (81-96), whose despotism Tacitus depicts in strong terms. The *Agricola* was written in A.D. 98. In the *Germania,* written in the same year, some see a satire on Roman decadence while others consider it a political pamphlet deprecating an aggressive Roman policy against the bellicose Germans; most, however, regard it as merely an indication of interest in the Teutonic tribes, though no evidence that Tacitus visited Germany exists. *The Historiae,* an annalistic work written at some time before 112, was originally divided into fourteen books, but of these only the first four and part of the fifth, covering the years 69-70, remain to us. In the case of the *Annales,* though sixteen books were originally written, we now have only the first four, a fragment of the fifth, most of the sixth, and the eleventh to the sixteenth, of which the beginning of the eleventh and the end of the sixteenth are missing. The extant portions cover the periods 14-37 and 54-66. This annalistic history is Tacitus'

latest known work, finished about 117 and recognized as his masterpiece.

Tacitus' renown as a historian was eminent during his generation, and succeeding centuries have not dimmed the brilliance of his fame. He is both our principal and our best source for the history of the period from 14 to 96. Of all Roman historians he is indubitably the most scientific by later standards; he falls beneath his competitors in some other respects, however, for while we may accept his factual statements with confidence, we must constantly query his interpretations, in which he is prone to color his facts "to point a moral or adorn a tale." Nevertheless, all competent students concur that among Roman historians Tacitus has neither superior nor rival in portraiture of character, in psychological penetration of motive, and in graphic power to paint in a few words an act or a situation; he is unsurpassed among his rivals in his moral earnestness, his use of rhetorical devices, and his mastery of epigrammatic characterizations, of which several have passed into the common heritage of literature. Tacitus models his later style on that of his predecessor in historiography, Sallust (86-34 B.C.), belonging to the Golden Age of Latin literature; he is for all that a true son of the Silver Age of Latinity in his brevity, poetic color, Greek usages, variety of expression, and figurative style.

CORNELIUS TACITUS

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P. R. C.-N.

**TACLOBAN** [tɑklo′bɑn], a Philippine chartered city, the capital of Leyte Province, situated on the northeast coast of Leyte Island. Historically, it is famous as the temporary capital of the Philippines after the United States Army landed on Leyte, and served as Gen. Douglas MacArthur's headquarters early in the campaign to recapture the islands from the Japanese in World War II. Tacloban is the agricultural and distributing center of the eastern Visayan Islands and the only Leyte port with terminal facilities. The town lies at the base of a small peninsula between Samar Sea and Leyte Gulf. Rice, corn, copra, and abacá are the principal crops of the surrounding region; mat making and basket weaving are the main handicrafts. There is a national airport 5 mi. southwest of the city. Pop. 1948 (town), 31,155; (chartered city), 45,421. A. Cu.

**TACNA** [tɑ′nɑ], the name of the southernmost department of Peru and of its capital, 620 mi. southeast of Lima and 170 mi. southwest of La Paz. Near the city, which was involved in the Tacna-Arica dispute with Chile, is the Campo de la Alianza, site of an important battle (1880) in the War of the Pacific (1879-1884). Tacna was awarded to Peru on Aug. 28, 1929. The city is the agricultural center of the region and manufactures cotton and sugar. There is a railway to Arica in Chile, 40 mi. to the south, and from there to La Paz in Bolivia. The city is also on the west branch of the Pan-American Highway going south from Vitor to Chile. The department, with an area of 4,922 sq. mi., is bordered by the departments of Moquegua on the northwest and Puno on the northeast, and by Bolivia on the west, Chile on the south, and the Pacific Ocean on the southwest. Although most of the terrain is barren hills, the province has some fertile oases producing fruit and vegetables. There are also some sulphur mining and a tanning industry. Pop. (off. est. 1947), 13,254, city; 42,070, department. *See also* TACNA-ARICA DISPUTE. S. G. I.

**TACNA-ARICA DISPUTE** [tɑ′nɑ ɑri′kɑ], a boundary disagreement in South America which led to the War of the Pacific (1879-1884), between Chile on the one hand and Peru and Bolivia on the other. The dispute arose in the mid-nineteenth century over the exploitation by Chile of valuable guano and nitrate deposits in sections of the Pacific coastal region that were claimed by Bolivia. In the ensuing war, which Peru entered on the side of Bolivia, Chile was victorious and, as a result, gained outright possession of Bolivia's entire seacoast territory and the Peruvian province of Tarapacá. Under the Treaty of Ancón (1883), between Peru and Chile, Peru also ceded Tacna and Arica to Chile for a period of ten years, after which a plebiscite was to be held to determine their permanent status. The decision, however, was postponed from decade to decade. At the close of World War I the United States was invited to supervise the plebiscite, but an attempt to hold it, under the supervision of Gen. John J. Pershing, failed because of national feeling in the rival countries. The question was finally settled by direct negotiation in 1929, when a division of the territory was agreed upon. Part of Tacna was then restored to Peru, but Chile retained the rest of that province and all of Arica. *See also* ARICA; TACNA. S. G. I.

**TACOMA** [tə′ko′mə], a port city in the central section of western Washington, the county seat of Pierce Co., situated on Commencement Bay, at the head of deep-sea navigation of Puget Sound and at the mouth of the Puyallup River, about 30 mi. south of Seattle.

**Harbor.** The Tacoma harbor is considered one of the best natural harbors in the world. There are 14 mi. of shoreline along it. To reach it from the Pacific Ocean vessels pass through the Strait of Juan de Fuca, Admiralty Inlet, and Puget Sound. The harbor is 4½ mi. wide at its entrance between Brown's Point and Point Defiance. It has an average width of nearly 2 mi. and a length from Brown's Point to the head of the harbor of approximately 2½ mi. There is an average depth of 25 to 30 fathoms.

**History.** In 1833 the first fort on the north Pacific coast was constructed 18 mi. south of the city's site by the Hudson's Bay Company for protection against the Indians. The fort, known as Fort Nisqually, has been reproduced in its entirety, including one of the original buildings, at Point Defiance Park in Tacoma. Tacoma was founded in 1868 when General Morton Matthew McCarver selected the site as the terminus for the Northern Pacific Railroad. He purchased the land and induced a California lumber company to build a sawmill, thus starting Tacoma's principal industry. The townsite he plotted near the mill was called Commencement

City, but in 1869 McCarver changed the name to Tacoma, which is said to be a corruption of an Indian term meaning "greatest white peak." A post office, which is preserved as a landmark in Point Defiance Park, was built in that year. In 1873 another post office was established 1½ mi. south under the name of New Tacoma. This community became the county seat in 1880. Tacoma made its appearance in the export-shipping field in 1881 when the first load of wheat was sent out. In 1884 the two neighboring communities consolidated as one city named Tacoma. The city has the commission form of government.

**Points of Interest.** The Olympic Mountains are northwest of the city; the Cascade Range is to the east. Tacoma is considered the gateway to Mount Rainier National Park, to the southeast, and it is 60 mi. southeast of Olympic National Park. Tacoma is reputed to have the tallest totem pole in the world, 105 ft. high, which was carved from a single cedar tree and presented to the city in 1903. The state historical museum contains numerous exhibits of Washington and Alaska Indian handiwork. The city has twenty-seven parks, comprising 1,616 acres. In Point Defiance Park there are a zoo, deep-sea aquarium, and numerous recreational facilities. Sutter's Exhibits, a rock collection, has a large display of fluorescent rocks.

**Institutions.** The College of Puget Sound is located in Tacoma, and Pacific Lutheran College is 7 mi. south of the city's center. Hospitals include an Indian hospital, Madigan General Hospital (an army hospital), a veterans' hospital, the Western State Hospital for the insane, and a county hospital.

**Federal Installations.** The armed services maintain several installations in the Tacoma area, including Fort Lewis (a 110,000-acre army post), Mount Rainier Ordnance Depot, McChord Field, and the Tacoma naval station.

**Transportation.** In addition to the steamship lines, transportation is provided by the Northern Pacific, the Great Northern, the Union Pacific, and the Chicago, Milwaukee, St. Paul and Pacific railroads. Air service is available at the joint Seattle-Tacoma airfield, about 15 mi. south of Seattle, which has flights by the Northwest, Pan American, Trans-Canada, United, West Coast, and Western air lines.

**Industry.** The city is one of the nation's largest furniture, door, pulp, and plywod centers. Tacoma's leading industrial establishments include a smelter, which refines copper, gold, and silver; railroad shops; shipyards; fruit canneries; and flour mills. The city is the center of the Northwest's electrochemical industry. The factory output also includes food products, castings, cranes, logging machinery, candy, and clothing. Pop. 1950, 143,673. S. D. M.

**TACTICS, MILITARY.** *See* Military Strategy and Tactics.

**TADEMA.** *See* Alma-Tadema, Sir Lawrence.

**TADPOLE SHRIMP,** a primitive freshwater crustacean belonging to the order Notostraca of the subclass Branchiopoda. Tadpole shrimps are usually brownish in color and have a broad oval shield covering the anterior segments, which gives them an appearance similar to that of miniature (1-in.) horseshoe crabs. They are usually found in temporary pools and, like many of the branchiopods, their presence in any particular locality can seldom be relied upon from one year to the next. In some rice-growing areas they are looked upon as pests which interfere with the growth of young rice shoots. The presence of related fossil forms in Cambrian deposits indicates that these unique animals are among the oldest of living crustaceans. F. A. C.

**TADZHIK SOVIET SOCIALIST REPUBLIC (TADZHIKISTAN)** [tajɪ′k, tajɪ′kɪstɑ′n], one of the sixteen constituent republics of the Union of Soviet Socialist Republics, located in west central Asia north of Afghanistan. With an area of 55,700 sq. mi., it is bounded on the north and west by the Uzbek S.S.R., on the south by Afghanistan, on the east by Sinkiang, and on the northeast by the Kirghiz S.S.R. Acquired as part of Russian Turkistan in 1895 and formed from parts of the former regions of Bukhara and Turkistan, it was admitted as a constituent republic of the Soviet Union on Dec. 5, 1929, and includes the Gorno-Badakhshan Autonomous Territory within its borders. The republic consists almost entirely of young folded mountains with elevations reaching below 2,000 ft. only in the extreme southwest, while in the east the Pamir Mountains average well above 10,000 ft., culminating in Mt. Stâlin, 24,590 ft., the highest peak in the Soviet Union.

Owing to the high elevation, the climate of the republic is rather severe for its latitude, and varies considerably with the relief. Mean January temperatures range from 25° F. to 32° F. and July temperatures from 60° F. to 65° F., while annual precipitation varies from 10 to 15 in. In the western semi-desert along the upper reaches of the Amu Darya and the Syr Darya rivers precipitation is only about 6 in. a year. Soil, in the mountains, is thin and leached, but in the valleys, particularly in the southwest, irrigation is practiced and the region is important for the growing of cotton. The Amu Darya on the southern border is the principal river; others include the Syr Darya, the Panj (or Pyandzh), the Kafirnigan, and the Vaksh, which flow through the mountains in deep gorges. There are many permanent glaciers in the Pamirs, and in the northeast, Lake Kara Kul lies well over 2 mi. above sea level. The low rainfall prevents the growth of extensive forests except at fairly high elevations in the mountains.

The capital and leading city is Stalinabad, in the western portion of the republic. Other important cities include Khorog in the southeast, Garm in the central part, and Kurgan Tyube in the southwest. The population consists primarily of Tadzhiks, an Iranian people of Mohammedan faith and indigenous to the region. Those in the western Pamirs are the oldest of the peoples of Central Asia. The smaller portion of the population is made up of Uzbeks, Kirghizes, and Russians. Native culture is actively encouraged and over 300 schools of various levels are included in the republic's educational system. A branch of the Soviet Academy of Sciences has also been established in Tadzhikistan.

Agriculture is the historic occupation of the Tadzhiks, and the principal crop is Egyptian long-staple cotton, grown on the irrigated lands of the river valleys. Other crops include rice, apricots, and other fruits. The silkworm is cultivated, and grain and orchard crops are grown in the mountain regions. In the high semi-desert valleys of the eastern Pamirs, 13,000 ft. above sea level, the nomadic Kirghizes raise cattle, sheep, and yak.

The chief industries of Tadzhikistan are concerned with mining and the processing of agricultural products. Coal, petroleum, gold, silver, platinum, radium, lead, zinc, tin, uranium, arsenic, and bismuth are mined in the mountains. In addition, there are many large phosphate deposits and still-untapped areas rich in minerals. Kurgan Tyube boasts the largest cotton-ginning mill in central Asia; Stalinabad has a large meat-processing combine; and Leninabad has fruit-canning facilities. Other factories producing leather goods, cotton and silk fabrics, and cottonseed oil support the

republic's industrial activity. Four thousand miles of roads over difficult mountains and the wide use of air transport have supplanted trails, thus reducing the inaccessibility of Tadzhikistan. Stalinabad is also reached by a railway from Uzbek S.S.R. Pop. (est. 1954), 1,800,000.

R. H. F. and L. M. A.

**TAEGU** or **TAIKYŪ** [taigu, taikyu], the fourth largest city of Korea, in the southern part of the peninsula, 60 mi. northwest of Pusan on a tributary of the Naktong River, at 35° 47′ N. lat. and 128° 31′ E. long. Taegu has a continental climate, with cold winters and hot summers. The average annual temperature is about 53° F., and the average annual precipitation is 35 in. Silk spinning is the major economic activity of Taegu, and the city is an important market center and railroad junction. During the Korean War Taegu was for several weeks in 1950 the provisional capital of South Korea. Communist attempts to capture the city were prevented by U.N. forces. Pop. 1946, 269,113. J. E. F.

**TAFFARI, RAS.** *See* Haile Selassie I.

**TAFFETA.** *See* Textile Fabrics (*Silk and Rayon*).

**TAFFRAIL LOG.** *See* Navigation (*Instruments for Sea Navigation*).

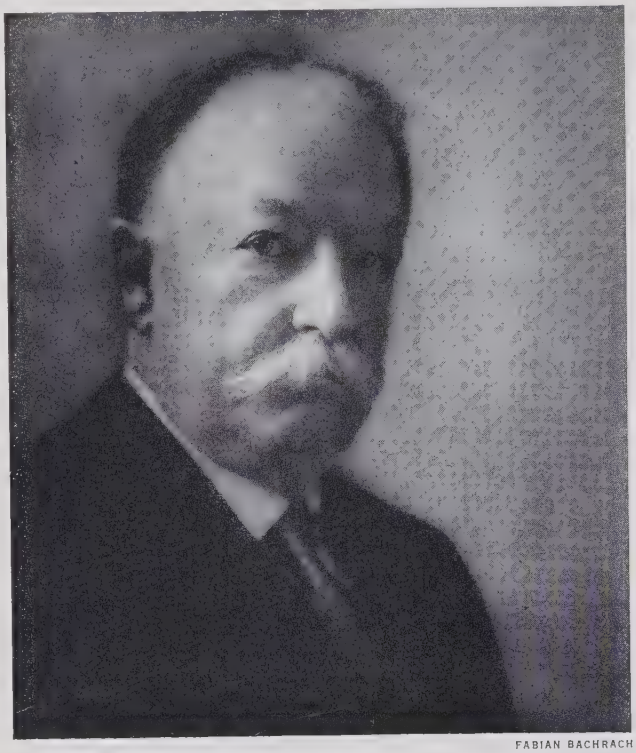
**TAFT, LORADO** (1860-1936), American sculptor, lecturer, and writer, was born April 29, 1860, in Elmwood, Ill. He studied sculpture at the University of Illinois and in Paris. After 1886, through his teaching of sculpture and the history of art at the Art Institute, Chicago, Taft broadened the scope of art education throughout the Middle West. In 1903 he wrote *The History of American Sculpture*. Taft's work is conservative, but robust and flexible; he was pre-eminent as a fountain sculptor. He died in Chicago Oct. 30, 1936.

P. E.

**TAFT, ROBERT ALPHONSO** (1889-1953), American political leader, was born in Cincinnati, O., on Sept. 8, 1889, a son of President William H. Taft. He graduated from Yale University in 1910 and from the Harvard University Law School in 1913, at the head of his class. He was admitted to the Ohio bar in 1913, and began practice at Cincinnati. Because of defective eyesight, he was rejected for military service in World War I, but was assistant counsel in the United States Food Administration (1917-1919) and counsel to the American Relief Administration in Europe (1919-1921). Taft was elected to the Ohio house of representatives in 1921, and served until 1926, being speaker in the latter year. In 1931-1932 he served a term in the Ohio senate, and in 1936 was Ohio's "favorite son" in the Republican national convention. Two years later he was elected to the U.S. Senate and was re-elected in 1944 and 1950, serving in that body until his death. During his years in the Senate, Taft was one of its most influential members and had considerable effect on legislation. He was a sponsor of the controversial Taft-Hartley labor act. Taft proved to be an effective spokesman for the conservative element of the Republican Party and gradually assumed leadership of that group. He was the candidate of that wing of the party for the Republican presidential nomination in 1940, 1948, and 1952, although failing in each instance to capture the nomination. His most successful bid came in 1952 when he was defeated at the convention by Dwight D. Eisenhower only after a bitter intra-party struggle. After Eisenhower's election to the presidency, Taft was a powerful, though at times critical, supporter of the Eisenhower administration. He died in New York after a brief illness on July 31, 1953.

T. R. H.

**TAFT, WILLIAM HOWARD** (1857-1930), twenty-sixth President of the United States, was born in Cincinnati, Ohio, Sept. 15, 1857. His father, Judge Alphonso Taft, diplomat and cabinet officer under President Ulysses S. Grant, and his mother, Louisa Torrey Taft, were of early New England families of English descent. After attending the public schools in Cincinnati, Taft was sent to Yale University, from which he graduated in 1878, second in his class. He then entered a Cincinnati law school and subsequently was admitted to the Ohio bar. His progress in the law was steady if not spectacular. From the first, however, it was apparent that Taft was not too ambitious, and his brothers chided him for his lack of diligence in preparing a case. The



FABIAN BACHRACH

*WILLIAM HOWARD TAFT, TWENTY-SIXTH PRESIDENT OF THE UNITED STATES*

facts seem to indicate that throughout his life Taft preferred to depend upon his native brilliance rather than upon hard work to see him through a problem. He was a sociable person, loving life and good company too much to spend a great amount of time in lonely, concentrated labor. This trait was to cost him dearly when he became president.

Shortly after graduating from law school, Taft, following in the footsteps of his father, became interested in Republican politics. He was an excellent public speaker, and his services to his party soon resulted in his being appointed assistant prosecuting attorney of Hamilton County. From that time on, except for several brief periods, he was to hold public office for the rest of his life. In 1882 he was appointed the collector of internal revenue for Cincinnati, a position he resigned after he had refused to discharge several able men because of their political affiliations. Soon afterwards, however, he was made assistant solicitor of Hamilton County, an office he held until 1887 when he was appointed a judge of the Ohio Superior Court. Meanwhile, in 1886, he had married Helen Herron of Cincinnati.

Taft was never happier than when he was on the bench. The calm, leisurely tempo of judicial life suited his nature

as it had his father and grandfather before him. Since he had been appointed only to fill an unexpired term, he stood for election in 1888 and won his only victory at the polls prior to his election as President. With regret he left the Ohio bench in 1890 to accept the position of Solicitor General of the United States under President Benjamin Harrison. He was extremely successful in his new position, winning the great majority of his cases. The true bent of his nature was again shown when, in 1892, against the advice of his wife, he joyfully resigned to become a Federal circuit judge. On this second most important court in the nation, Taft soon acquired the reputation of being a reactionary, and especially of being an antilabor judge. This label, fastened to him largely as a result of his findings in a few celebrated injunction and contempt-of-court cases, was not quite just. For although Taft was and remained a conservative all his life, he did believe in the right of labor to organize and strike, and so expressed himself from the bench. As a judge he was especially solicitous of labor suits for compensation resulting from industrial accidents. However, his willingness to issue labor injunctions earned for him the opposition of organized labor for the rest of his life. One of his most important decisions, the Addyston Pipe and Steel Co. case, affirmed by the Supreme Court, enjoined conspiracy in restraint of trade and put the first teeth into the Sherman Anti-Trust Act.

In 1896 Taft was chosen dean of the University of Cincinnati Law School; later he was urged to become a candidate for the presidency of Yale University. In 1900 President William McKinley appointed him president of a commission to establish civil government in the Philippine Islands. A year later he was made the civil governor of the islands. His work in restoring normal civil life throughout the Philippines brought him to the attention of President Theodore Roosevelt, who twice offered to appoint him to the United States Supreme Court. Regretfully declining in each instance, Taft remained in the Philippines until he considered his job there finished, leaving only to accept an appointment as Secretary of War in 1904. Roosevelt and Taft made a happy combination. Taft's unimpeachable integrity, his complete faithfulness, and his easygoing nature made him a perfect foil for the restless and impetuous President. He soon became Roosevelt's most trusted adviser, one of his most successful administrators, and his ablest trouble-shooter. Whenever a situation became too difficult for lesser men to handle, it was Taft who was sent to "sit on the lid," as Roosevelt phrased it.

Meanwhile, Roosevelt's second term was approaching an end. Many of Taft's friends were already booming him as the successor. For a long time Taft refused to become an active candidate, but when Roosevelt himself chose him he accepted, and was elected over William Jennings Bryan in 1908 by an electoral vote of 321 to 162. The legislative record of the Taft administration was an impressive one. In the four years, additional power was given to the Inter-State Commerce Commission, a postal savings and a parcel post system were created, and civil service was extended. A new cabinet post, that of Secretary of Labor, was added, and the sixteenth and seventeenth amendments were passed providing for a national graduated income tax and for the direct election of senators, respectively. Moreover, Taft energetically continued Roosevelt's "trust-busting" policies and his conservation program. In ordinary times and with ordinary luck this record should have commended the President to the country, but the times were not ordinary. For one thing, the nation, spurred on by Roosevelt's preachings, was excessively reform-minded, and the President appeared, by comparison at least, to be timid in his adoption of new ideas. For another, the President had the misfortune to follow the extremely colorful and adroit Roosevelt, and, although Taft was one of the most likable of men, he was neither colorful nor politically acute. Taft was too easygoing, with a disposition to trust his subordinates too much, too dilatory in his preparations, and probably too conservative to suit the existing temper of the country. Soon after his election he called Congress into special session to enact a campaign promise to reduce the tariff. The Payne-Aldrich Act of 1909 was not a reduction in any real sense, and Taft's approval of the bill and subsequent ardent defense of it served to alienate progressive sentiment in the nation. He further sacrificed liberal support by his dismissal of Gifford Pinchot from the forestry service, a militant supporter of conservation and a personal friend of Theodore Roosevelt. In the ensuing famous Ballinger-Pinchot episode, a congressional investigation cleared Richard A. Ballinger, Secretary of the Interior, of any wrongdoing, but left the public critical of the administration's conservation policies. Taft suffered a further defeat in his proposal for tariff reciprocity with Canada. He called a special session of Congress, against the advice of his party leaders, and then widened the split in his party to obtain passage of the act, only to see the project rejected by a Canadian election.

As progressive sentiment grew more critical of him, Taft relied more upon the conservative elements of his party. In the primaries of 1910 the President worked actively for the defeat of liberal Republicans. Soon after the Democratic victories of that year a movement was started to by-pass Taft in 1912 and nominate a progressive Republican. Senator Robert M. LaFollette was the early choice of the progressives, but by 1912 they were supporting Theodore Roosevelt. Since his return to the country in 1910 Roosevelt had become increasingly critical of the President, and when in 1911 Taft authorized an anti-trust suit against the United States Steel Corporation, for actions that had had Roosevelt's approval when President, the two men were completely estranged. In an acrimonious campaign of personalities the two old friends waged a bitter battle. Roosevelt was probably the choice of the majority of the Republicans, but Taft controlled the national party organization and prevented the seating of Roosevelt delegates, thus insuring his own nomination. Enraged, Roosevelt bolted and formed the Progressive Party. In the three-cornered contest that followed between Taft, Wilson, and Roosevelt, Taft received the electoral votes of Vermont and Utah alone.

Retiring from the presidency on March 4, 1913, Taft became the Kent Professor of Constitutional Law at Yale University. During the same year he was elected president of the American Bar Association. Taft thoroughly enjoyed the quiet academic atmosphere, but World War I brought him back into public life. He made a notable record as joint chairman of the War Labor Board, and in 1918 and 1919 he spent a great amount of time lecturing in support of the League of Nations. Taft had always been a firm supporter of world peace, and an international organization capable of administering and enforcing international law greatly appealed to him. Nevertheless, in the elections of 1920 he supported Warren G. Harding on the ground that the election of a Republican administration was the best way of insuring that the nation join the League. His opposition to Wilson brought him again into close contact with Theodore Roosevelt, and before Roosevelt's death they had renewed their friendship.

Perhaps the happiest moment in Taft's life came in 1921 when President Harding appointed him Chief Justice of the United States Supreme Court. Of all occupations, the bench had always held the greatest attraction for him. As Chief Justice, Taft was responsible for many administrative improvements in the Federal judicial system. At his suggestion regular conferences of the senior circuit court justices were held, and thus a degree of regularity was imparted to the hitherto unco-ordinated system. It was at his suggestion that Congress passed an act giving the Supreme Court the power to decline to hear certain classes of cases. When Taft first came to the Court it was considerably behind in its work; at his resignation its schedule of cases was almost current. Taft was also largely responsible for obtaining congressional approval for the construction of the new Supreme Court Building. During the time Taft was Chief Justice the Court, in its decisions, tended toward the conservative. Taft himself was a conservative force, although on several notable cases he wrote liberal opinions. His dissenting opinion on the District of Columbia minimum wage law for women was particularly expressive of the progressive viewpoint. On Feb. 3, 1930, the Chief Justice resigned from the Court because of ill health. A month later, on March 8, he died; he was buried in the Arlington National Cemetery.

Taft was extremely large and jovial, and moderate in everything save eating. Unfortunately, he became president in an age of reform to which he could not give full assent. This, plus his peculiar lack of political sense, made his presidential years not entirely happy. However, his achievements as judge and administrator were considerable.

G. E. M.

**TAFT-HARTLEY ACT.** *See* INDUSTRIAL PRODUCTION; LABOR IN THE UNITED STATES, HISTORY OF; LABOR PRACTICES AND EMPLOYMENT (*Methods of Settling Labor Disputes*).

**TAGANROG** [təgʌ′nrɔ′k], a seaport and industrial city in the western Rostov region of the Russian Soviet Federated Socialist Republic, southwest Soviet Union, 39 mi. west of Rostov-on-Don. It is located on the flat northern coast of the Gulf of Taganrog, the northeastern extension of the Sea of Azov. The original thirteenth-century colony of Italian merchants was destroyed by the Mongols. A small community soon developed, and after a period of Turkish control it became Russian in 1769. Taganrog was an important port and trade center between the mid-eighteenth and mid-nineteenth centuries, but its port then declined when the harbor became silted up. The harbor, icebound about three months annually, is reached by channels dredged in the bed of the shallow Sea of Azov. Taganrog has greatly expanded as an industrial city under the Soviet regime. It was heavily damaged in the fighting involved in its capture in World War II by the Germans, Oct. 19, 1941, and its recapture by Soviet troops on Aug. 30, 1943. Anton Chekhov was born in Taganrog in 1860. Notable is the former Imperial Palace in which Alexander I died in 1825. A deep-water port for Rostov-on-Don, Taganrog transships from that city many of its export items, including grain, caviar, wool, butter, and oil; the imports are chiefly items for local consumption. The city's industries, largely Soviet-developed, include in their output iron and steel, steel boilers, turbines, hydraulic presses, metal tubing, machines, leather, and leather products. Pop. (est. 1950), 175,000.

C. C. H.

**TAGAYTAY** [tɑ′gitī′], a Philippine city, 33 mi. south of Manila, in Cavite Province, Luzon. Located on a ridge 2,000 ft. above sea level and overlooking Lake Taal and the inactive Taal Volcano on an island in the lake, the city is a market center for coffee, fruit, coconuts, and vegetables grown in the area. Pop. 1948, 5,233.

**TAGORE, SIR RABINDRANATH** [tɑ′gor] (1861-1941), renowned Hindu poet and educator, was born in Calcutta on May 6, 1861. He received his education from his father, whom he accompanied on numerous pilgrimages and trips throughout India. In 1877 he went to England to study law but returned to India the following year. His first poems were imitations of two older Bengalese poets, Chaulidas and Vidyapati, and in 1879 he published his first original work *Bhānu Sings* ("Evening and Morning Songs"). Tagore composed music for over 3,000 songs, including many of his later lyrics. In 1884 he married, and in 1885 he went to Shilaida, on the banks of the Ganges, to look after his father's estates. It was here that he came into contact with the genuine native life, and his later works depicted this experience. Many of his better-known works were written in this period of Tagore's life. These works include *Gītanjalī* (1912), *The Crescent Moon* (1913), *The Gardener* (1913), the drama *Chitra* (1913), and *The Hungry Stones* (1916).

In 1901 he founded the Santiniketan ("Home of Peace") school for boys at Bolpur in Bengal. The school, now an international institution known as Visva-Bharati, was Tagore's main work during the rest of his life. In 1912 Tagore visited England and, a year later, America, where he delivered many lectures which were ultimately published as *Personality* (1917) and *Nationalism* (1917). In 1913 the poet was awarded the Nobel Prize for Literature, and in 1915 he was knighted. Tagore published numerous poetic works, novels, short stories, essays, sermons, and dramas in Bengalese, some of the most important of which have been translated into English. His later publications include the drama *The King of the Dark Chamber* (1914), his autobiography *My Reminiscences* (1917), *Sacrifices and Other Plays* (1917), a second series of *Gītanjalī* (1919), *The Home and The World* (1919), *The Wreck* (1921), *Red Oleander* (1924), *Broken Ties* (1925), *Fireflies* (1928), *Thoughts From Tagore* (1929), and *The Religion of Man* (1931). Tagore died in Calcutta on Aug. 7, 1941.

F. Go.

**TAGUS** [te′gəs] (*Span.* Tajo; *Port.* Tejo), the longest river of the Iberian Peninsula, flowing in a southwesterly direction across Spain and Portugal and emptying into the Atlantic Ocean at Lisbon. Its length is about 550 mi. It rises in the Albarracin Range of the Montes Universales, on the border of Aragon and New Castile in east central Spain, about 100 mi. west of the Mediterranean Sea; it flows in a northwesterly direction into Guadalajara Province, then turns southwestward to Toledo, from which it follows a generally westward course to the Portuguese border. There, between Alcántara and Montalvão, for a distance of about 30 mi., the river forms a part of the border. In Portugal it flows southwestward between the provinces of Beira and Alentejo, crosses Estremadura, and at Santarém begins to form a broad estuary. At Lisbon, where the estuary reaches its maximum width, the river provides a fine landlocked harbor opening into the Atlantic. For most of its long course the Tagus traverses a dry, hilly terrain, where grazing is more important than agriculture. The river is navigable for about 80 mi. from Lisbon northeast to Abrantes, Portugal, but above that point the stream is broken by rapids and cataracts. The only large city on its banks in Spain is Toledo; in Portugal there are Santarém and Lisbon. The river's chief tributaries are the Jarama, Alberche, and Alagón, all in Spain.

G. Q.

YLLA

*The Himalayan tahr,* Hemitragus jemlaicus, *a beardless wild goat*

**TAHITI** [tɑ′hiti; tɑhi′ti], largest and best known of the Society Islands, located in the South Pacific Ocean west of the Tuamoto group at 17° 45′ S. lat., 149° 30′ W. long. It is 33 mi. long and 15½ mi. wide, and has an area of about 600 sq. mi. At least seven peaks on the island rise higher than 4,000 ft. Of these Mount Orohéna, 7,339 ft., is the highest. The principal town is Papeete, on the northwestern coast, containing about 10,000 people, mainly Polynesian natives. About the same number live elsewhere on the island.. Tahiti became part of a French protectorate in 1843. In 1888 it was made the capital of the French Pacific island colonies, including the Tuamotos, Marquesas, and Austral islands, which in 1946 were constituted an overseas territory of the French Union. There are few native land animals on Tahiti, and few birds and insects, but the lagoons offshore teem with fish and shellfish. The main industries are the preparation of copra and sugar, and the export of pearl shell and phosphates. Pop. (1941) 23,133. R. G. B.

**TAHITI CHESTNUT,** a name given to the edible kidney-shaped seed of *Inocarpus edulis,* a tree of the pea family. It is highly prized as food by the natives in Polynesia and Malaya. M. G. W.

**TAHLTAN.** *See* Indian Tribes, North American (*Western and Eastern Subarctic*).

**TAHOE, LAKE** [tɑ′ho; te′ho], a lake which lies astride the boundary between California and Nevada, situated approximately 10 mi. west of Carson City, Nev. It is one of the most beautiful lakes of the western United States and the center of a thriving summer-resort area. Lake Tahoe extends 21.6 mi. from north to south and has a maximum width of 12 mi. Most of its area of 193 sq. mi. lies in California. Situated at an altitude of 6,225 ft., it is rimmed by snow-clad peaks of the Sierra Nevada towering 4,000 ft. above its surface. The lake was formed partly by glaciation and partly by faulting, erosion, and volcanic damming. It is said to be the deepest lake in the United States, the known depth being at least 1,500 ft. G. Q.

**TAHR** [tɑ′r], a short-horned goat, *Hemitragus,* which inhabits the forested mountains of India. It stands 36 to 42 in. high, and its very shaggy coat is dark brown or reddish brown. Unlike the true goats, male tahrs are not bearded. Both sexes have horns which measure up to 17½ in. The animals are gregarious and feed together in grassy openings and among the cliffs. Usually one kid at a birth is born, either in June or in July; it is much paler than its parents. V. H. C.

**TAI.** *See* Asiatic Tribes (*Sinitic*); Siamese.

**TAICHŪ** [taitshu], a city in west central Formosa (Taiwan), 118 mi. southwest of Kiirun. In 1888 Taichū was made the site of a prefectural government, controlling eight neighboring counties. During Japanese rule (1895-1945) Taichū was elevated to the status of a municipality, a position it still maintains. To the southeast of the city is the Confucious Temple, the site of a famous institute known as the Wen Kai Academy, founded in 1825 by Chinese scholars. It had a collection of 300,000 volumes of Chinese literature, the largest on Formosa. However, during Japanese rule the whole collection was either burned or removed by the Japanese as a measure to eradicate Chinese influence on the island.

Taichū is situated at the center of a fertile, irrigated basin surrounded by mountains. It has a tropical climate, with a mean temperature of 68° F. and an average annual rainfall of from 60 to 80 in. The surrounding region is chiefly agricultural, with bananas and sugar cane the chief crops and tea, rice, vegetables, tobacco, and sweet potatoes also grown. There are several large sugar mills and refineries in and near Taichū. The city, center of a local transportation network, is on a branch of the main railroad line connecting the large cities of the island. About 20 mi. east of Taichū is the scenic Sun-Moon Lake, the most attractive resort on Formosa. The hydroelectric plants on these adjoining lakes supply power to the sugar refineries, lumber mills, and other factories in near-by towns. Pop. 1947, 82,259. A. C. T.

**TAIF** [tɑ′if], a town in Hejaz, in western Saudi Arabia, about 35 mi. southeast of Mecca, situated 6,000 ft. above sea level in the mountains that form the western rim of the Arabian plateau. It serves as Hejaz's summer capital and is a popular resort for the residents of Mecca. The climate is hot and dry. Temperatures frequently exceed 100° F., and the precipitation, most of which falls in August, is usually not much more than 10 in annually. The city is noted in Arabia for its rose gardens and fruit orchards. Although the residents of Taif only became converts to Mohammedanism after Mohammed had successfully laid siege to the community in the seventh century, Taif was the only community in Arabia other than Mecca and Medina to remain faithful to the Prophet immediately after his death. In 1924 many of the residents were massacred after Taif was captured from the Turks by the invading Wahabi forces of ibn-Saud. Pop. (est.), 8,000. J. E. F.

**TAIHOKU** or **TAIPEH** [taihoku, tai′be′], a city at the northern end of Formosa (Taiwan), the capital of Taiwan Province and the largest city on the island, located on the east bank of the Tansui River, 18 mi. southwest of Kiirun, the leading seaport of Formosa, and 13 mi. southeast of the mouth of the Tansui. Taihoku was a political center from

the time Taiwan became a part of China during the Yüan Dynasty (1206-1368), though Chinese rule was administered either from the Pescadores Islands, in the Formosa Strait, or from Fukien Province. Formosa was proclaimed a province of China in 1885, and a viceroy was sent to administer the island from Tainan, in the southwest. The Japanese, to whom the island was ceded under the Treaty of Shimonoseki in 1895, used Taihoku as the site of their director general's office. During World War II the city was damaged by Allied bombing raids, and at the end of the war a Chinese administrator, by virtue of the Cairo Declaration of Dec. 1, 1943, ruled the island from Taihoku. In December 1949 it was made the provisional capital of the Chinese Nationalist government when the government fled from the Chinese mainland.

Taihoku is built on a broad plain surrounded by forests. The climate is tropical and humid, with a mean temperature of 70° F., and an average annual precipitation of 84 in. The typhoon season, from August to December, proved disastrous to the city in 1911, when many buildings were destroyed by the strong winds. Sites of interest in the city include the zoological garden, the botanical garden, the national museum, the Confucian temple, and the Temple of the Goddess of Mercy. Educational institutions include the National Taiwan University and the Taiwan Provincial Teachers' College. Tea manufacturing, sugar refining, and fruit canning are the city's chief industrial activities. Taihoku is on the railroad connecting the larger Formosan cities, and it has international air-line connections. Pop. 1947, 326,407. A. C. T.

**TAIKWA REFORM.** *See* JAPAN (*History*).

**TAILORBIRD,** any one of a number of species of small (5 in.) Old World warblers combined in the genus *Orthotomus* of the family Muscicapidae, or insect eaters. They occur in the Asiatic tropics from India to the Philippine Islands. Their bills are long and straight. The graduated tails of the males are longer in summer than in winter. Plumage is usually gray or green above, with the crown rufous, and whitish or yellowish beneath. Some tailorbirds are little-known forms of the forests; others are familiar garden species. They are of especial interest for their remarkable nests, made from growing leaves stitched together with cobweb and vegetable fiber. Using her bill as a needle, the female passes the thread back and forth, knotting the ends, until a purselike structure is formed, within which the eggs are deposited. H. G. De.

**TAIMYR.** *See* TAYMYR (*Dolgano-Nenets*).

**TAINAN** [tainɑn], a city in western Formosa (Taiwan), 223 mi. southwest of Kiirun. The city, the third largest on Formosa, is 3 mi. from its seaport, Ampin, with which it is connected by railway. Tainan was settled by Chinese immigrants in 1590, but was occupied by the Dutch for the first half of the seventeenth century. At the end of the Ming Dynasty (1368-1644), a severe famine occurred in Fukien Province, compelling thousands of its people to seek a living on Formosa. The viceroy of Fukien provided the immigrants with shipping accommodations and also awarded each refugee "three ounces of gold and one head of ox" as encouragement to reclaim the "neglected island" of China. Conflict with the Dutch was avoided, since the Chinese restricted themselves to farming outside the city. When the general of the Ming Dynasty, Cheng Ch'eng-kung (Koxinga), captured Tainan from the Dutch in 1661, he changed the name of the city from Cheh Ching Lou to Tungtu ("Eastern Capital"). His son Cheng Ching renamed it Tung Ling, and during the reign of the Manchu emperor Kuang Hsü (1875-1908) the name was changed to Tainan ("South of Taiwan").

Tainan has the largest number of temples of any Formosan city, including the Fah Hwa Sze dedicated to the Buddhist saint, the Confucian Temple, the Kwan Kung Tze dedicated to the Chinese national hero of the period of the Three Kingdoms, and, the most revered of all, the shrine dedicated to Cheng Ch'eng-kung. Other places of interest include the Museum of Natural History, the industrial museum of native products, and the tropical Tainan Park. Taiwan College of Engineering is located in the city.

Tainan is situated on a relatively flat coastal plain and has a tropical climate, with a mean temperature of 71° F. and an average annual rainfall of 48 in. The region is chiefly agricultural, and tropical fruits are important. There are sugar and rice mills, alcohol stills, and local trading and manufacturing establishments in the city. It is on the railroad connecting the chief Formosan cities. Pop. 1947, 142,183. A. C. T.

**TAINE, HIPPOLYTE** [tɛ′n] (1828-1893), French historian, critic, and philosopher, was born at Vouziers, in the Ardennes, Apr. 21, 1828. He attended the Collège Bourbon and the Ecole Normale in Paris. His doctor's thesis,

*HIPPOLYTE TAINE*

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*Les Sensations* (1856), was refused at the Sorbonne because of its materialistic doctrine. Taine then substituted another thesis, *La Fontaine et ses fables* (1860), which remains to this day the best study on the fabulist. His *Essai sur Tite-Live* (1856) had already stated some of the fundamental ideas in Taine's literary criticism, notably that of the dominant faculty, which in Livy is found to be the oratorical gift. His *Idéalisme anglais* (1864) and *Positivisme anglais* (1864) are excellent studies of Thomas Carlyle and J. S. Mill, respectively. But Taine's most important work in literary criticism is the *Histoire de la littérature anglaise* (1863). His complete theory of literary criticism, formulated in the introduction, finds in that book its widest application. He maintains that literature, like every other manifestation of human activities, is a necessary product, that it is determined by three factors—race, milieu, and moment—to which must be added an element personal to each author, his dominant faculty. He applied the same principles to the history of art (*Philosophie de l'art,* 1865-1867), which he taught for more than twenty years at the Ecole des Beaux-Arts. And he

attacked the spiritualistic philosophers of the nineteenth century in *Les Philosophes classiques au XIX siècle* (1857). *De l'intelligence* (1870) is a positive statement of his philosophy, giving a materialistic and deterministic explanation of the world, according to which all knowledge proceeds from sensations. Teaching that all psychological phenomena are only physiological phenomena, this book became the bible of Naturalism and wielded a decisive influence on French thought at the end of the nineteenth century. In *Les Origines de la France contemporaine* (I, *Ancien régime;* II, *Révolution;* III, *Nouveau régime,* unfinished, 1875-1894) Taine considered historical developments as the inevitable results of given causes. He exhibited a violent dislike for the French Revolution and attempted a rehabilitation of the old French monarchy, in spite of its acknowledged abuses. Taine is also the author of a novel, *Notes sur Paris, vie et opinions de M. Frédéric-Thomas Graindorge, de Cincinnati, U.S.A.* (1868), which is a satire of contemporary customs. Taine's theories of literary criticisms and of history are undoubtedly too rigid, embodying as they do extremes of positivism and pessimism. But his influence was great on such writers as Zola and Maupassant, and he deserves considerable praise for the systematic approach of his method, for his personal integrity, and for his devotion to what he considered the truth. Taine was created an honorary D.C.L. of Oxford in 1871 and in 1878 was elected a member of the Académie Français. He died in Paris, Mar. 9, 1893. F. V.

**TAINO.** *See* Indian Tribes, South American (*Principal Linguistic Families*).

**TAIPEH.** *See* Taihoku.

**TAIPING REBELLION** [tai′pɪ′ŋ] (1850-1864), the most important of the nineteenth-century Chinese risings against the Manchu Dynasty. Hung Hsiu-ch'üan, who had failed his civil-service examinations and in his youth had had a serious illness accompanied by visions, was inspired by Protestant missionary tracts to preach to and assume leadership of a group of professing Christians in Kwangsi and Kwangtung provinces, styling himself the Brother of Christ. Later he preached the T'ai P'ing Kwoh (Heavenly Dynasty of Perfect Peace), calling himself T'ien-wang (Heavenly King). His followers believed he had been sent to redeem the land of China from worship of idols as well as to replace the Manchu Dynasty with the Taiping.

Hung Hsiu-ch'üan led the first rising in Kwangsi Province in July 1850, plundering and ravaging westward into Yünnan Province. In April 1852, after a period of further organization, he advanced northward through Hunan and Hopeh provinces and then down the Yangtze River to Nanking, which was captured in March 1853. Once established in Nanking, he sent northward an army which almost reached Tientsin and other armies south into Anhwei, Honan, Hupeh, and Kiangsi provinces, where they established isolated strongholds after ravaging the countryside. The government that was established combined a rigidly enforced form of Christianity with many socialistic features, but it was poorly organized and administered. The loss of some of the more capable leaders delivered Nanking into incompetent hands. What might have been a revolution for which the nation was ready degenerated into factional quarrels between jealous rivals for power, culminating in a purge in 1856 which considerably weakened the movement. Moreover, the conservative Confucian literati and the wealthier classes preferred to support the Manchu Dynasty, which to them stood for stability. After 1858 abler leaders emerged, particularly Li Hsiu-ch'eng, who regained lost territory in central China and moved into the rich coastal provinces of Kiangsu and Chekiang in 1859 and 1860.

When Taiping forces threatened Shanghai, they were opposed by a mixed force of Europeans and Chinese imperial troops. The eventual suppression of the rebellion was largely due to Tsêng Kuo-fan, a Hunanese scholar and military leader. Under his direction, Changsha and Wuchang, both in Hupeh Province, were retaken and Kiangsi Province was cleared. In 1857 Tsêng assumed command of the imperial forces in Chekiang and, assisted by Tso Tsung-t'ang and Li Hung-chang, pushed the rebels far to the west. By the spring of 1862 Tsêng was able to turn his attention to Nanking. Reinforced by the Ever-Victorious Army, commanded first by the American Frederick Townsend Ward and after his death by the British Charles George Gordon, the imperial army advancing from Shanghai laid siege to Nanking. At the same time Tso Tsung-t'ang went southward to pacify Chekiang Province, and Gordon and Li Hung-chang cleared the territory north of Nanking. On June 30, 1864, T'ien-wang, viewing all as lost, committed suicide. On July 19 Nanking was taken by assault, bringing the rebellion virtually to an end. The destruction wrought was very great throughout the territory involved in the rebellion, and the benefits were few. W. J. H.

**TAIRONA.** *See* Indian Tribes, South American (*Other Linguistic Groups and Tribes*).

**TAI SHAN** [tai′shɑ′n], the holiest of the five sacred mountains of China, rising at the center of Shantung Province near the city of Taian and 50 mi. south of Tsinan, the capital of Shantung. The Tai Shan, on which the legendary Emperor Shun (c. 2255-2205 B.C.) offered sacrifice to heaven, and which is often referred to as the Eastern Peak of Heaven, is 5,048 ft. high. The main route from the foot to the summit is about 15 mi. in length, traversed for the most part by a flight of 6,300 stone steps, roughly divided into three sections. The whole course is marked by I Tien Men (First Heaven Gate) at the foot, Chung Tien Men (Middle Heaven Gate) in the middle, and Nan Tien Men (South Heaven Gate) on the top. On the mountain are hundreds of temples, numerous scenic spots, and thousands of stone tablets bearing the calligraphy of scholars, poets, and emperors of practically all dynasties. A. C. T.

**TAISHO.** *See* Yoshihito.

**TAIWAN.** *See* Formosa.

**TAIYUAN.** *See* Yangkü.

**TAJIKS.** *See* Asiatic Tribes (*Indo-Iranian*).

**TAJ MAHAL** [tɑ′j məhɑ′l], at Agra, in north central India, the crowning jewel of Indo-Islamic architecture. A Mogul ruler, Shah Jahan, erected the monument as a tomb for a beloved wife, Arjumand Banu, better known by her title of Mumtaz Mahall or Taj Mahal (Crown of the Palace). In 1631 she died after bearing fourteen children in eighteen years. The construction of the tomb, begun the following year, employed some 20,000 workmen for nearly twenty years.

The tomb is the focal point of a vast rectangle, two thousand feet long and one thousand feet wide. One short side of this composition, that on the north, runs along the bank of the Jumna River. The southern third of the area includes service structures and ends at a monumental gateway leading into the walled section, which comprises the major part of the

rectangle. Within the walls is a fragrant garden, one thousand feet square and bisected along its axis by a narrow, reflecting pool. Across the entire river side is a raised platform with high minarets at its four corners. At the west side of the platform is a mosque and at the east a reception hall or guest house.

The tomb, at the center of the platform, is a square in plan, with chamfered corners. Within the considerable thickness of the walls is a circumambulatory corridor marked by octagonal chambers within each corner angle. At the center of the plan is the octagonal tomb chamber, crowned by a shallow dome and entered through lofty portals in each face of the structure. This chamber contains the cenotaphs of Taj Mahal and Shah Jahan, surrounded by a pierced marble screen, while the actual burials are in a crypt directly below the chamber. On the exterior, the lofty arched portal in each face is flanked by two stages of niches, and the structure is crowned by a bulbous dome which rises far above the shallow inner dome of the tomb chamber. Simple proportions dictate plan and elevation relationships: the width of the structure equals its total height, and the distance from the floor level to the parapet over the arched portals is just one half the total height.

On both the exterior and interior the structural core is covered with white marble decorated with designs inlaid in semiprecious stones. The infinite variety and richness of detail and the consummate skill displayed in the execution make the structure unique in its general class. The structure seems to mirror the mood of the skies: at sunset the marble assumes a rosy hue.

Designs for the tomb were submitted by the leading architects of the Mogul empire. The one chosen for execution was possibly by a Persian, Ustad Isa. The plan is quite similar to that of a monument to an earlier Mogul ruler, Humayun, erected at Delhi in 1564 after the designs of a Persian architect, and the general architectural type may be traced to still earlier examples in Turkestan and northern Iran. *See also* Mohammedan Architecture. D. N. W.

**TAJO.** *See* Tagus.

**TAKAMATSU** [takamatsu], the capital of Kagawa Prefecture, situated on the northern tip of Shikoku Island, Japan, facing the Inland Sea. The city has a mild and pleasant climate. The winter temperature averages about 40° F., and the season is fairly dry with considerable sunshine, while the summer average is between 75° and 80° F., with considerable humidity. With only 40 to 60 in. of rain annually, the region is too dry to be a major rice-producing area, but some rice, barley, buckwheat, rye, sweet potatoes, and mulberry trees are grown. The hinterland is heavily forested, and some lumbering is carried on; paper, lacquer, and salt are produced, and fishing is an important activity. Takamatsu is a flourishing transshipment and transportation point and is the center of trade between Honshu, the main island, and Shikoku. Trade is carried on by railroad to all parts of Shikoku as well as by coastal shipping to Kyushu and Honshu. Ritsurin Park, comprising about 134 acres, is one of the finest in Japan. Pop. 1954, 124,557. J. E. F.

**TAKAOKA** [takaoka], a city located at the base of the Noto Peninsula on the central west coast of Honshu Island, Japan. It lies about 15 mi. west of Toyama, in Toyama Prefecture, on the Imisu River. Takaoka has wet, foggy, and cloudy winters, with considerable snowfall and temperatures averaging about 35° F.; the summer season is warm and humid, with an average temperature of 78° F. The precipitation varies between 60 and 80 in. annually, most occurring during the winter season. Takaoka changed from a small village to a feudal castle site in 1609, when Toshinaga of the Maeda clan built Takaoka Castle. It has since become an industrial city specializing in hardware and bronze, dye, lacquer ware, cotton spinning, and textiles. It is also a center of the rice trade. Pop. 1954, 123,925. J. E. F.

**TAKASAKI** [takasaki], a city in central Honshu Island, Japan, 65 mi. northwest of Tokyo. It is located in Gumma Prefecture near the upper course of the Tone River, at the western edge of Kwanto Plain. Takasaki has an almost continental climate, with warm summers and cool winters. The average annual temperature is about 54° F. The major crops of the area are rice, mulberry trees, tea, tobacco, vegetables, millet, and buckwheat. The city is a rail junction, and has silk and cotton mills; machine tools and bamboo and other wooden wares are also produced. Pop. 1952, 97,900. J. E. F.

**TAKELMA.** *See* Indian Tribes, North American (*North Pacific Coast*).

**TAKIN** [ta′kin], a heavily built wild mountain goat, *Budorcas,* which inhabits the higher parts of the eastern Himalayas, eastward to the border of Kansu Province of western China. In the west, the shaggy hair of the takins is dark brown, but the color becomes progressively paler until, in the eastern part of the range, it is almost yellowish white. The horns are sharp and bend abruptly backward. A large set spreads 16 in., and each horn is about 20 in. long. When fully grown, the takin weighs 500 to 600 lb. In summer, takins gather in large herds and frequent dense thickets of bamboo and rhododendron near the timber line. They descend into the sheltered valleys in winter. V. H. C.

**TAKLAMAKAN** [taklamaka′n], a desert of central Asia, in the Tarim Darya (River) Basin in the Chinese province of Sinkiang, formerly Chinese Turkestan. The Tarim Darya borders the desert on the north, and the Altyn Tagh and the Kunlun Mountains are on the south. Taklamakan is entered by several rivers, including the Cherchen, the Keriya, and the Khotan. It also has several lake areas, including the Lop Nor (Lop Lake), which has twice shifted its basin. Since the soil is good, the region could become agricultural if irrigation facilities were developed. The climate is an extreme continental type, with almost no rainfall, sub-zero winters, and high temperatures in the summer. The desert is practically uninhabited except along the southwestern and northwestern borders, where there are oases such as Sufu (Kashgar), Soche (Yarkand), Qarghaliq or Karghalik (Yehcheng), and Hotien (Khotan), on the southwest, and Uch Turfan (Wushih), Akosu (Agsu), and Kucha (Kuche), in the northwest. Ancient trade routes followed these lines of oases. Although the area belongs to China, most of the inhabitants are Turko-Moslems. J. E. F.

**TAKOMA PARK** [təkómə], a city in Montgomery Co. and Prince Georges Co., in southern Maryland, located on Sligo Creek, at the northern boundary of the District of Columbia, of which it is a suburb. It was chartered in 1890 and has the mayor-council form of government. The chief activities of the community center about the headquarters of the Seventh-day Adventists in the city. Takoma Park is the seat of Washington Missionary College operated by that group. Washington Sanitarium is to the northeast, just

across Sligo Creek. Transportation is provided by the Baltimore and Ohio Railroad. Pop. 1950, 13,341.

**TAKORADI** [tɑ′korɑ′di], a seaport, opened in 1928, about 113 mi. southwest of Accra on the British Gold Coast. It is the only deep-water harbor between Sierra Leone and Nigeria. In 1953 the harbor facilities were vastly expanded. It can handle large ships up to 40 ft. draught. The main export is manganese ore. Takoradi, united in 1946 with Sekondi to form one municipality, has railway connections with the capital, Accra, via Kumasi. Pop. 1948, 17,800; Sekondi-Takoradi, 44,557. R. G. W.

**TALAING.** *See* Asiatic Tribes (*Other Linguistic Families*).

**TALC** or **STEATITE** [sti′ətait], a hydrous magnesium silicate, $Mg_3Si_4O_{10}(OH)_2$. It occurs both massive and foliated. Rock consisting dominantly of talc is called soapstone. Talc is the softest of minerals (hardness of 1) and has a soapy feel; it is also sectile. It is a secondary mineral formed by the hydration of such primary magnesium silicates as olivine and pyroxene, or of other secondary minerals such as serpentine. The agent of alteration may be either ground or magmatic waters. The resulting deposits are lenticular, but some individual lenses are very large. Talc is a mineral of many uses. Its white color, ready pulverization, and low cost make it a good filler in paint, paper, ceramics, rubber, textiles, linoleum, composition roofing and flooring, oil cloth, and many other substances. The slippery feel makes it useful in foundry facings and cosmetics. Massive talc can be shaped and heated to form refractories and electric insulators. Soapstone, because of its composition and character, can be sawed into desired shapes for use as laboratory table tops, sinks, switchboards, fireless-cooker stones, and griddles. This material was used by the ancients for carvings. The United States is the leading producer of talc and soapstone. The most important talc states are New York, North Carolina, California, and Vermont; all of the soapstone comes from Virginia. Other countries producing considerable tonnages of these materials are Manchuria, France, and Italy, with Canada, India, Norway, and Spain appearing in the production statistics as lesser sources. K. K. L.

**TALCA** [tɑ′lkɑ], capital of the agricultural and wine-producing province of Talca, Chile, on the Claro and Piduco rivers, 155 mi. south of Santiago. The city is the most important in the central valley and one of the largest manufacturing centers in the country. The principal products are shoes, tobacco, flour, paper, beds, liquor, and rubber tubes. The city, founded in 1692, was entirely rebuilt after earthquakes in 1742 and 1928. Pop. (off. est. 1945), 43,749. S. G. I.

**TALCAHUANO** [tɑ′lkɑwɑ′no], the port of Concepción, Chile, located 5 mi. from that city. It is on Talcahuano Bay and has the best harbor in Chile. An important grain and export center, it is a port of call for steamers. Pop. (off. est. 1945), 33,423. S. G. I.

**TALE OF A TUB, A,** a satire by Jonathan Swift, published in 1704 but probably written about 1697. Swift tells us that his satire is directed against "the numerous and gross corruptions in religion and learning." The corruptions in religion are dealt with in the story of three brothers, Peter, Martin, and Jack, and what they did with the coats left to them by their father with strict injunctions that the coats were not to be altered in any particular. Peter represents the Roman Catholic Church, Martin the moderate Protestantism of the Church of England, and Jack the fanatical Protestantism of the dissenting sects. The story is told with brilliant wit, sometimes open to charges of irreverence and indecency, in alternating "sections" of the book. The intervening sections are devoted to "digressions" in which Swift deals with the "corruptions in learning." Most famous of these is the profoundly ironical "Digression on Madness" (Section IX). R. K. R.

**TALE OF IGOR'S CAMPAIGN, THE** (*Slovo o Polku Igoreve*), a Russian prose poem dealing with an expedition of Prince Igor Svyatoslavich against the Polovtsy in 1185. It falls into three parts: (1) a narrative of the campaign and of the defeat and capture of Igor; (2) a lyrical interlude, containing a prophetic dream by Grand Prince Svyatoslav, uncle of Igor; poetic appeals to various Russian princes; and a lament by Igor's wife, Yaroslavna; and (3) a narrative of Igor's escape from captivity. The first and third parts tell of events related briefly in the *Kiev Chronicle.* The *Tale* came to light in 1795, when Count A. I. Musin-Pushkin announced that he had found it in a bound volume of manuscripts purchased from the Archimandrite of the Spaso-Yaroslavsk Monastery. It was published in 1800; the manuscript perished in the burning of Moscow in 1812. Most Russian scholars accept the *Tale* as the finest poetic work of early Russian literature, composed soon after the events of which it tells, but there are some students who have denounced it as an eighteenth-century forgery. Two items in the controversy may be mentioned here. In general there are few points of contact between the *Tale* and undoubted productions of the Russian Middle Ages. But a work on the battle which took place in 1380 between Grand Prince Dmitri of Moscow and the Tatars under Mamay, preserved in two main redactions, distinctly resembles it in both substance and phrasing: it is safe to say that either the writer of the *Zadonshchina* (*The Campaign beyond the Don*) knew the *Tale* and made rather clumsy attempts to imitate it, or else some person of literary talent read the *Zadonshchina,* was impressed by it, and used it as a chief source for a clever forgery, embroidering on its style. Furthermore the *Tale* contains allusions, of a sort elsewhere unparalleled, to Russian heathen deities, though Christianity had become established in Russia by the close of the tenth century. These allusions may be due to living popular tradition or they may be due to eighteenth-century pseudoclassicism. The question of authenticity is not settled, but among scholars of Russian nationality there are few skeptics. G. R. N.

**TALE OF TWO CITIES, A,** a historical novel by Charles Dickens, was written in 1859 as a weekly serial for the author's newly founded magazine, *All the Year Round.* The two cities are London and Paris, before and during the French Revolution. For his background material Dickens relied heavily on Carlyle's history of the period; under the pressure of weekly installments he found it advisable to restrict the number of characters in the novel. Its highly dramatic climax, in which Sidney Carton, out of love for Lucie Manette, rescues her husband from prison and takes his place at the guillotine, made the stage adaptation of the story the most steadily popular play ever based upon a Dickens novel. DeL. F.

**TALES OF A WAYSIDE INN,** a series of narrative poems, published in three parts (1863, 1872, 1874) and later collected in one volume (1886), by Henry Wadsworth Longfellow. The author used the framework pattern made

familiar by Chaucer and Boccaccio. Supposed to be stories told in turn by a group of congenial companions as they sit about the fire at a rural inn at Sudbury, near Boston, the twenty-one poems deal with a variety of themes, ranging from local American history to old stories based on Boccaccio, the Talmud, and legends which Longfellow had collected in Europe. Best known among them is *Paul Revere's Ride*. Others include *The Legend of Rabbi Ben Levi, The Saga of King Olaf, King Robert of Sicily,* and *The Birds of Killingworth.* L. L.

**TALES OF HOFFMAN, THE.** *See* CONTES D'HOFFMAN, LES.

**TALI.** *See* AFRICAN PEOPLES.

**TALISMAN.** *See* CHARM.

**TALISMAN, THE,** one of Sir Walter Scott's *Tales of the Crusaders,* first published in 1825. The story is laid in Palestine about 1191, during the Third Crusade. A truce is declared between the troops of Richard and Saladin's Saracens, and it is during this truce that the events of the story occur. Saladin helps the hero, Kenneth of Scotland, to redeem himself after he has lost the English banner that he was guarding. Kenneth is forced to become Saladin's bond servant, but eventually returns as the Knight of the Sleeping Leopard, kills the thief of the banner, Conrade of Montserrat, and wins Lady Edith of Plantagenet. Saladin and the Saracens prove far more interesting than the English or Scotch. The "Talisman" is a pebble, possessed by Saladin, which has miraculous healing powers. W. Ru.

**TALLADEGA** [tælədi′gə], a city in east central Alabama, the county seat of Talladega Co., situated 60 mi. east of Birmingham, at the foot of the Blue Ridge Mountains, in an agricultural area devoted to the growing of cotton. Rich and varied natural resources of the region include marble similar to the Italian in quality and beauty; gold, brown, and gray iron ore; bauxite; talc; china clay; dolomite; and red and yellow ocher. Onyx Cave and mineral springs are natural features of the district, and Talladega National Forest and Cheaha State Park containing Cheaha Mountain, 2,407 ft. above sea level and the highest point in Alabama, are near by. The townsite was formerly the property of the Creek Indians, and its name is Indian for bordertown since it was on the edge of the Indian lands. In 1813 at the Battle of Talladega Andrew Jackson defeated a force of hostile Creek Indians. The community, incorporated as a city in 1835, has the commission form of local government. It is the seat of Talladega College for Negroes and the Alabama State Institution for the Deaf and Blind. The Louisville & Nashville, the Southern, and the Atlantic Coast Line railroads furnish transportation. Besides cotton textiles, the town's chief manufacture, the local factories produce pine and hardwood lumber, pipe and pipe fittings, textile machinery parts, cottonseed oil and meal, and plumbing supplies. Pop. 1950, 13,134.

**TALLADEGA COLLEGE** [tælədi′gə], an accredited, coeducational, privately controlled college of arts and sciences for Negroes, affiliated with the Congregational Church and supported in part by the American Missionary Association. The college occupies a 300-acre campus in the city of Talladega, Ala. Instruction was begun in 1867 and a charter was issued two years later. The A.B. in liberal arts and the B.Mus. are offered. Fraternities and sororities are in existence on the campus. Dormitories and dining halls are provided for both men and women, and all out-of-town students must live either in dormitories or in approved houses. Scholarship assistance is generous and a loan fund has been established. *For statistics see* COLLEGES AND UNIVERSITIES. J. R. To.

**TALLAHASSEE** [tæləhæ′si], the state capital and the county seat of Leon Co., in northwestern Florida, about 160 mi. west of Jacksonville, and about 30 mi. north of the Gulf of Mexico. The city is a trading center for a timber and fertile farming region, but its chief activities are political and educational. An Indian name meaning old town, Tallahassee was the capital of the Apalachee Indians when Hernando de Soto and his men reached it in 1539. Two Franciscan friars came in 1633, and Fort San Luis was built about 1640 as the headquarters for seven missions. In 1824 the city was chosen as the state capital, the first legislature meeting in a log building. In 1825 the city charter was granted. Tallahassee is the seat of the Florida State University and the Florida Agricultural and Mechanical College for Negroes. Sites of interest include the state capitol (completed in 1845), the governor's mansion, the Martin Building with the museum of the State Geological Society, the Presbyterian Church, the Columns, the Groves, the May Oak where the May Festival is held, ruins of Fort San Luis, and the grave of Prince Achille Murat. The city is served by the Seaboard Air Line Railroad and planes of the Eastern and the National airlines. The factory output of Tallahassee includes naval stores, lumber products, feed, packed pecans, mattresses, and insecticides. The farms in the region raise livestock, corn, sweet potatoes, and cotton. Pop. 1950, 27,237.

**TALLAHATCHIE RIVER** [tæləhæ′tshi], 301 mi. long, one of the headwaters of the Yazoo River. It rises in Tippah Co., northeastern Mississippi, flows southwestward, and is joined by the Coldwater River in Quitman Co. and by Yalobusha and Greenwood rivers in Leflore Co., west central Mississippi. These rivers combine to form the Yazoo River. The Tallahatchie is a sluggish, narrow stream in summer, but it widens to 300 ft. or more during winter floods, which have caused great destruction. The Sardis Dam, in Panola Co., now helps to control floods of the river. The Tallahatchie has been improved for small-boat navigation as far as Minter City, Leflore Co. The river drains 3,500 sq. mi. of cotton-growing land. J. E. F.

**TALLAPOOSA RIVER** [tæləpu′sə], 268 mi. long, one of the headwaters of the Alabama River. It rises in Paulding Co., northwestern Georgia, and flows 56 mi. southwest into northeastern Alabama, where it bends southward and then west to join the Coosa River north of Montgomery, Ala. In Tallapoosa Co., Ala., it enlarges to form Martin Lake. The river crosses the fall line at Tallassee, Ala., dropping 60 ft. in a series of rapids and falls. The lower part of the river is navigable. J. E. F.

**TALLENSI.** *See* AFRICAN PEOPLES.

**TALLEYRAND-PÉRIGORD, CHARLES MAURICE DE (PRINCE DE BÉNÉVENT)** [ta′le′rã′] (1754-1838), French bishop, politician, and diplomat, was born in Paris, Feb. 13, 1754. Neglected by his parents, who were members of the court of Louis XV, he was placed under the supervision of his grandmother in Périgord, in southwestern France. Later he attended the Collège d'Harcourt in Paris and, as a crippled second son, ineligible for the army, was destined for the Church. Early in 1789 he was appointed bishop of Autun and not only represented his see in the Estates General but

also drafted the instructions or *cahier* for the clergy of his area. In the Estates General and the National Assembly (May 5, 1789-Sept. 30, 1791) he favored creation of a strong constitutional monarchy. He also advocated (October, 1789)

*PRINCE CHARLES MAURICE DE TALLEYRAND-PÉRIGORD*

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confiscation of the Church lands and took the oath supporting the civil constitution of the clergy which tended to nationalize the Church. He disapproved the dethronement of Louis XVI on Aug. 10, 1792, but he had already taken precautions for his personal safety on Sept. 14, 1792, and left France for England, where he hoped to be of service in preventing war between France and Great Britain. He foresaw correctly that the opening of the Scheldt Valley would prejudice peace between the two nations. After war broke out, on Feb. 1, 1793, he was forced to leave England. He sailed for the United States on Feb. 3, 1794, and spent approximately two years in that country, traveling, studying commercial conditions, and serving as land agent for potential emigrants. Returning to France early in 1796, Talleyrand ingratiated himself with the Directory (1795-1799) and was appointed minister of foreign affairs. During two years of service (July 1797 to July 1799) he handled, among other problems, negotiations for peace with Great Britain. He favored Napoleon Bonaparte's cause before the *coup d'état* Nov. 9, 1799, which brought the latter to power. Napoleon reappointed Talleyrand to the post of foreign minister in December 1799, and Talleyrand served in this capacity until after the Treaty of Tilsit with Russia, July 7-9, 1807. Thereafter, he cooled toward the imperial regime and secretly worked for the restoration of the Bourbon dynasty. In return for his support, Talleyrand represented Louis XVIII at the Congress of Vienna, where his adroit diplomacy succeeded in gaining moderate terms for defeated France. In September 1815 he retired from the ministry and, with the exception of his service as ambassador to Great Britain (1830-1835) during the early years of the reign of Louis Philippe, did not again participate in public life. He died in Paris on May 17, 1838. R. M. Br.

**TALLINN** [ta'llɪn], formerly Reval or Revel, a seaport and the capital of the Estonian S.S.R. of the Soviet Union, located on the northwest coast of Estonia, about 200 mi. southwest of Leningrad, at 59° 25′ N. lat. and 24° 45′ E. long. It is picturesquely situated on the deep, wide-open Tallinn Bay on the southern coast of the Gulf of Finland. The lower town lies on a sandy coastal plain, while back of it on a limestone escarpment, 150 to 250 ft. higher, is the upper town.

*OLD WORLD CITY OF TALLINN, CAPITAL OF THE ESTONIAN S.S.R. OF THE SOVIET UNION, WAS FOUNDED BY THE DANES IN 1219.*

EWING GALLOWAY

**History.** A Danish settlement existed on the site as early as 1093; in 1219, after destroying the old Estonian fortress of Lindanissa, the Danes built a fortress in the town. It was controlled at various times between the thirteenth and sixteenth centuries by the Livonian Knights, the Danes, the Teutonic Knights, and Sweden, having become a member of

the Hanseatic League in 1284. After undergoing a serious conflagration in 1433, pestilence in 1532, bombardment by ships from Lübeck and Denmark in 1569, and prolonged though unsuccessful sieges by the Russians in 1570, 1571, and 1577, its trade was largely destroyed. It surrendered to Peter the Great in 1710 and prospered under him and his successors, who fortified it as a military port. It was unsuccessfully attacked by the Swedish fleet in 1790 and blockaded by the British in 1809 and again by the British and French in 1854 and 1855. The port became capital of the new republic of Estonia in 1919 and retained its status in the Soviet republic established in 1940. Tallinn was captured by the Germans and heavily damaged in World War II; it was liberated by Soviet troops on Sept. 22, 1944, and returned to Soviet control.

**Economic Activities.** Tallinn is a terminus of main railway lines from Leningrad and Moscow and also serves the rail network of the western Soviet Union. An important medieval port, the city again became a busy Baltic port under the Russians before 1918; its harbor, kept open by icebreakers, handled approximately one-fifth of Russian imports, including all cotton and many other products for the Moscow industrial area. It regained its trade during the early 1930's after a setback following World War I, but it received severe damage to its facilities in World War II. Exports include textiles, grain, timber, paper, and cement; imports include foodstuffs, cotton, and coal. There is also trade in flax, hides, and bristles. Industrial establishments include iron and steel works and food factories (both largely ruined by the Nazis in World War II), cotton mills, sawmills, pulp mills, and shipbuilding and repairing yards. Fishing and fish canning are leading industries. Pop. (est. 1950), 250,000. C. C. H.

**TALLITH.** *See* TEPHILLIN.

**TALLOW TREE,** also known as vegetable tallow, a small tree, *Sapium sebiferum,* 25 to 30 ft. high, of the spurge family. A native of China, it is naturalized and cultivated in the southern United States and other tropical lands. It has broad oval leaves, beautifully red-colored in age, and small flowers in terminal spikes. Within the thick fruiting capsule are large white seeds having a waxy covering, used for making candles and soap, and for dressing cloth. The name is sometimes given to the candlenut. J. C. Wis.

**TALLULAH** [təlu′lə], a city in northeastern Louisiana, the parish seat of Madison Parish, situated on the banks of the winding Roundaway Bayou, 55 mi. east of Monroe. Cypress and oak timber are found in this region. Cotton is the chief crop, and other agricultural products are corn and hay. Tallulah has local manufactures of lumber, soft drinks, and cottonseed-oil products. It is governed by a mayor and council. The community is served by the Illinois Central and the Missouri Pacific railroads. Pop. 1950, 7,758.

**TALMUD** [tæ′lmɑd], a body of rabbinic literature, consisting of the Mishnah (a compilation of laws) and the Gemara (the discussions and expositions revolving around the Mishnah). There are actually two Talmuds, the Palestinian and the Babylonian, each having different Gemara but the same Mishnah text; of the two the Babylonian Talmud is the more important and has received far more attention.

The Mishnah, after its completion in about 200, became the basic text of study in the Babylonian and Palestinian rabbinical academies. Not all of the sixty-three tractates of the Mishnah (which is divided into six orders) have Gemara; in the Babylonian Talmud, for example, only one tractate of the first order is so provided, presumably because the laws in the first order, dealing mainly with agriculture, were inapplicable in Babylonia. The Palestinian Talmud was completed about A.D. 400 and the Babylonian about a century later; the latter, containing approximately 2,500,000 words is about three times as large as the former. The authors of the Mishnah were called *tannaim;* those of the Gemara *amoraim;* and the editors of the Talmud, who flourished immediately after its completion, *saboraim.* The language of the Mishnah is Hebrew and that of the Gemara is Aramaic, with some admixture of Hebrew, but there are dialectal differences between the Palestinian Aramaic and the Babylonian. Among the notable translations of the Talmud, or of parts of it, are a complete English translation of the Mishnah by Herbert Danby (1933); a German translation of the Babylonian Talmud by Lazarus Goldschmidt; French and Latin translations of the Palestinian Talmud; and an English translation of the Babylonian Talmud (Soncino Press, England), completed in 1948.

The material in the Talmud may be classified as Halachic or legal, and Haggadic. The Haggadic portion is extremely varied and includes ethical, legendary, exegetical, historical, homiletic, scientific, and biographical matter. About thirty per cent of the Babylonian Talmud and about fifteen per cent of the Palestinian Talmud consists of Haggadah.

The Talmud represents the Oral Law and is considered, by Orthodox Jews, as authoritative as the Written Law, represented by the Bible. According to tradition, the teachings of the Oral Law are Mosaic in origin and have been transmitted by word of mouth through the centuries. The Talmudic law is in a sense derivative of Biblical law, but to a great extent it reflects the custom and thought of its own times. The Jewish observance of Biblical law is determined by Talmudic interpretation, and all codes of Jewish law are based on the Talmud; hence the Talmud is of prime importance in Jewish religious practice. Occasionally, certain Jewish groups have rejected the authority of the Talmud, notably the Karaites in the Middle Ages; in modern times, Reform Judaism does not consider the Talmud binding in matters of religious observance. Throughout the centuries the Talmud has been the principal, sometimes the sole, subject of study in Orthodox rabbinical schools. An encyclopedic work, encompassing virtually all aspects of human life, the Talmud is also of great interest to students of law, history, religion, ancient culture, language, and literature. See also AMORA; HAGGADAH; HALACHAH; JUDAISM; KARAITES; MIDRASH; MISHNAH; ORAL LAW; TANNA. M. A. G.

**TALUS** [te′ləs], in Greek mythology, a Cretan man of bronze, made by Hephaestus. Talus heated himself red-hot and clasped in his embrace strangers who arrived on the island. When the Argonauts stopped at Crete, he was captured by Castor and Pollux and destroyed by Medea. Talus was also the name of a nephew of Daedalus. *See also* DAEDALUS. G. E. D.

**TAMANDUA.** *See* ANTEATER.

**TAMAQUA** [təmɑ′kwə], a borough in Schuylkill Co., in east central Pennsylvania, situated on both banks of the Little Schuylkill River, 32 mi. north of Reading. Anthracite coal has been mined extensively since its discovery in 1817. Tamaqua was founded in 1799 and incorporated in 1829. It annexed the village of Newkirk in 1920. Tamaqua is gov-

erned by a mayor and council. Transportation is supplied by the Reading and the Lehigh & New England railroads. Manufactures include iron and steel products, women's underwear and dresses, explosives, canned goods, and book covers. Fruit, grain, poultry, and truck farming are carried on in the area. Pop. 1950, 11,508.

**TAMARACK.** *See* LARCH.

**TAMARIN** [tæ′mərɪn], any marmoset of the genus *Leontocebus,* found in South America. A distinctive characteristic of the genus is the length of the canine teeth, which are longer than the incisors. The face is covered with silky hair, the mustache often being of impressive size. The body fur is black, mottled with red or gray. The tail is not ringed, as in typical marmosets. The ears are big, the eyes large, bright, and shiny. Tamarins travel in small groups. They are timid, but show little fear of man, being found even in city suburbs. They occupy woods or scrub growth, where they climb in the manner of squirrels. *See also* MARMOSET.
R. T. H.

**TAMARIND** [tæ′mərɪnd], a tall evergreen tree, *Tamarindus indica,* of the pea family, probably native to southern Asia and tropical Africa, and long cultivated in the tropics of both

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*The tamarind tree,* Tamarindus indica

hemispheres as an ornamental, and for its edible fruit. It is successfully grown in southern Florida. The tree grows as high as 80 ft., has a trunk reaching 8 ft. in diameter, and bears pinnate leaves of 20 to 40 oblong leaflets, and loose clusters of pale yellow flowers, veined with red. The plump, reddish-brown pod, 3 to 8 in. long, has a thin, brittle shell and 1 to 12 flat, glossy seeds enclosed in brown pulp. The acid pulp, which contains sugar, is used in cooking, and to make cooling beverages; it has medicinal uses also. The tamarind is a standard article of diet in the Orient, and an important export of many countries. J. C. Wis.

**TAMARISK** [tæ′mərɪsk], a genus, *Tamarix,* of deciduous shrubs and small trees of the tamarisk family, comprising about 75 species native to western Europe, the Mediterranean region, India, and eastern Asia. Several species are cultivated ornamentally for their feathery foliage and profuse bloom; some are used as sand binders and windbreaks, and in seaside plantings. These trees have small, usually scale-like leaves on very slender branches, and showy clusters of pink or white flowers. The French tamarisk, *T. gallica,* a small pink-flowered tree of the Mediterranean region, growing as high as 30 ft., is sparingly naturalized in the United States. *T. mannifera* is known for the "manna" produced on it by the punctures of an insect, *Coccus manniparus.* The Athel tamarisk, *T. aphylla,* a small tree of western Asia having green, pointed twigs, has been widely planted as a windbreak in the California desert region. Dyestuffs and medicinal preparations are produced from several species of tamarisk.
J. C. Wis.

**TAMAROA.** *See* INDIAN TRIBES, NORTH AMERICAN (*Eastern Woodland*).

**TAMAULIPEC.** *See* INDIAN TRIBES, NORTH AMERICAN.

**TAMBOURINE** [tambʊri′n], a musical instrument of indefinite pitch, consisting of one or two parchment heads stretched over a wooden hoop strung with metal jingles. The jingles are set in vibration by striking or rubbing the head of the tambourine or by shaking the whole instrument. Used in southern European folk music since the Crusades, and in Western band and orchestral music since the nineteenth century, the tambourine is modeled after the frame drum which has been played in the Near East, usually by women, for thousands of years. A similar drum, struck with a beater, is the magic-working instrument of Siberian and Amerindian medicine men. W. Li.

**TAMBOV** [tʌmbɔ′f], the name of both a governmental region and the city which is the administrative center of that region, located in the Russian Soviet Federated Socialist Republic, in the western Soviet Union.

**The City.** The city, an industrial community, is situated on a broad lowland in a dissected rolling area, on the nonnavigable Tsna River, 273 mi. southeast of Moscow. Founded in 1636 as a Muscovite frontier fortress, Tambov became an important cereal trade center in the early nineteenth century. The city and surrounding area were largely devastated during the civil conflict between 1917 and 1920. Noteworthy buildings include a seventeenth-century five-domed cathedral, Lutheran and Roman Catholic churches, and two museums. A railroad junction and grain collection center, it has synthetic rubber, thread, and leather and boot industries, machine and tractor shops, motor-repair works, and an electric-power plant. Pop. (est. 1950), 140,000. C. C. H.

**The Region.** Tambov Region or Tambovskaya oblast, an administrative unit of the central R.S.F.S.R., is situated in the Oka-Don lowland near the source of the Tsna River, which flows to the north into the Oka River. The region has an area of about 2,355 sq. mi., the surface of which is flat. Some forests are found along the rivers, but otherwise the region is mostly bare. Cereals, vegetables, hemp, sunflower seed, and coarse tobacco are grown. Livestock trade and horse breeding are also important. Michurinsk (Kozlov), the second city in importance, is a junction for the Moscow-Saratov-Rostov railroad line. Pop. (est. 1954), 1,500,000.
W. S. V.

**TAMBURLAINE** [ta′mbərlen] (Part I 1587, Part II 1588), a poetic drama by Christopher Marlowe, treating the rise of Timur Lenk (died c. 1405) "from a Scythian shephearde" to "a mightye monarque and . . . the Scourge of God." In conception and execution *Tamburlaine* was revolutionary. An almost plotless series of conquests is unified through the dominance of the aspiring hero, who expresses with passionate eloquence, in blank verse of unprecedented vigor and grace, the author's own worship of the Renaissance ideals of power and beauty. Marlowe's iconoclasm

and youthful optimism found a congenial outlet in the career of the Scythian conqueror. Immensely successful, *Tamburlaine* was widely imitated. Despite occasional bombast it brought to English drama the elevation of poetic passion, demonstrated the dramatic value of a great unifying character, and made blank verse the accepted vehicle of Elizabethan drama. P. W. T.

**TAMERLANE, TAMBURLANE,** or **TIMUR LENK** [tæ′mərlen, ta′mbərlen, tɪmʊ′r lɛ′ŋk] (1336-1405), Oriental soldier and conqueror, was born in 1336 at Kesh, 50 mi. south of Samarkand, in Transoxiana (Bukhara). He was descended in the female line from Genghis Khan, and, on the death of his father, became head of the family tribe of Berlas. He allied himself with the governor of Transoxiana, but intrigue obliged him to flee from Samarkand. When pursued, he turned on his enemies and defeated them. He allied himself with his brother-in-law, Amir Husein, but they were forced into the desert. It was during this period that Timur acquired his sobriquet, The Lame, as the result of arrow wounds which left him permanently crippled. Tamerlane, as he became known, and his ally were partially successful from 1363 to 1365, but eventually quarreled and became rivals. In 1369 Amir Husein was besieged in Balkh, forced to surrender, and put to death. Tamerlane, proclaimed sovereign, mounted the throne at Samarkand, assumed the title of Great Khan, and set out to reunite the Mongol conquests of his ancestor, Genghis Khan. From 1369 to 1380, he was engaged in conquering the neighboring states of Jatah to the east and Khiva to the west.

In 1380 he began his campaign into Persia, but his progress was slow. In 1384, after having taken Khurasan in Persia and consolidated his conquests, Tamerlane advanced northwest to the Black Sea. He occupied Azerbaidzhan, crossed the Araks, overran Georgia, and received the submission of the local princes of Kiptchak (that is, southwestern Russia). He then marched to Isfahan in Persia, captured the city, and put most of its citizens to death. Pyramids of skulls were his particular architectural fancy; after the storming of Isfahan he piled up 70,000. Shiraz hastened to surrender, but Toktamish, ruler of the Golden Hordes, successfully opposed Tamerlane and was not overcome until 1395.

In 1398 Tamerlane led his armies into India, an expedition which culminated in a triumphal entry into Delhi. He returned to his capital at Samarkand with great quantities of booty, but soon launched a campaign into Syria and Asia Minor, where he captured Baghdad, Aleppo, and Damascus. At the Battle of Angora (Ankara) in 1402, he defeated the Turkish sultan, Bajazet I, and took him prisoner. After his return to Samarkand, Tamerlane planned an invasion of China, but he was stricken by fever on the way and died at Atrar (Otrar), beyond the Syr Darya, on Feb. 17, 1405. His extensive empire quickly disintegrated, and his Persian domain was soon extinguished by another Turkoman horde. T. R. H.

**TAMING OF THE SHREW, THE** (c. 1595), a play by Shakespeare. This lively comedy shows the author engaged in rewriting an old play which had come into the hands of his company some years earlier. In the main he follows the scenario of his source, but he writes new and vigorous dialogue to bring out the characters of the drunkard Christopher Sly, Katherine, and Petruchio. Katherine, a violent, hot-tempered girl, is given in marriage to an adventurous stranger, Petruchio. In a long and comic struggle between them her self-will is broken by an outrageous but good-humored exhibition of the same quality on his part; the "shrew" is tamed, and becomes a loving, obedient wife. The underplot, drawn from George Gascoigne's *Supposes* (1566), deals with the courtship of Katherine's gentle sister, Bianca. T. M. P.

**TAMMANY HALL.** *See* Societies, Associations, and Organizations.

**TAMMERFORS.** *See* Tampere.

**TAMMUZ** [ta′mmuz], a god of agriculture and the flocks in Babylonian religion. Like the parallel Osiris of Egypt, his cult goes back to earliest Sumerian times. The cycle of Tammuz shows marked similarity between Sumero-Akkadian, Anatolian, and Egyptian myths, which have a tendency to group beliefs and practices around a central deity: Tammuz in Mesopotamia, Osiris in Egypt, Adonis in Syria and the Hellenistic world, and Attis in Asia Minor.

Tammuz was the lover of Ishtar, the goddess of love and fertility, who, at painful cost to herself, brought him back from the lower world after his death. His career symbolized the death of natural vegetation in winter and its rebirth in spring. The annual festival of Tammuz, coming just before the summer solstice, consisted of a period of mourning followed by rejoicing at his return. The Bible (Ezek. viii:14) refers to "the women weeping over Tammuz." The hot summer month of July, *Tammuz* in modern Arabic, was originally named after this deity by the Babylonians. E. J. J.

**TAM O' SHANTER,** a humorous narrative poem by Robert Burns, was written in 1790 at the urging of Captain Francis Grose (1731-1791), to accompany an engraving of the ruins of Alloway Kirk in the second volume of Grose's *Antiquities of Scotland* (1791). Burns himself called *Tam O' Shanter* his "standard performance in the poetical line"; it is one of the finest examples in all literature of the successful mingling of comedy and terror. DeL. F.

**TAMPA** [ta′mpə], a port city, the county seat of Hillsborough Co., on the central west coast of Florida. The third largest city in the state, it is situated on Tampa Bay, at the mouth of the Hillsboro River, and about 25 mi. north of St. Petersburg. Pánfilo de Narváez landed on the shores of Tampa Bay in 1528. Hernando de Soto arrived eleven years later, and, according to legend, he held a parley with the unfriendly Indians under the De Soto Oak, which is located on the campus of the University of Tampa. The hostile attitude of the Indians deterred white settlers until 1823, when a detachment of United States troops established Fort Brooke on the site. The community which developed was incorporated in 1855. The first railroad reached Tampa in 1885, and in 1887 the port was designated an official port of entry. The tourist trade was attracted to the city in 1889 on completion of the $3,500,000, Moorish-style, Tampa Bay Hotel in Plant Park. But it was the opening of the cigar industry in 1886 at Ybor City, which became a part of Tampa within three years, that brought about the city's growth. Tampa gained prominence during the Spanish-American War as the embarkation point for troops bound for Cuba. In 1950 a mayor and council administered the city.

The Tampa Bay Hotel, which has been converted to house the University of Tampa and the Tampa Museum, remains a leading landmark. There is a state tuberculosis sanitarium and a county home and hospital. Near by is the United States Air Force installation, MacDill Field.

Tampa is also a popular winter resort, one of the three leading industrial cities of Florida and one of the most important ports along the Gulf of Mexico. The city is the lead-

ing phosphate shipping point in the country. Other exports include lumber and canned citrus fruits. The Atlantic Coast Line and the Seaboard Air Line railroads provide rail facilities; the Eastern and the National air lines furnish additional transportation. Cigars, especially hand-made Havana cigars, continue to be the predominant product of Tampa's factories. Second in importance is canned citrus fruits, particularly grapefruit. The varied factory output also includes meat products, flour, feed, cement, fertilizer, and cans. Shipbuilding is important, and Tampa derives a large portion of its income from its wholesale distribution. Pop. 1950, 124,681. S. D. M.

*BUSINESS DISTRICT OVERLOOKING THE WATERFRONT AT TAMPA, FLORIDA*

EWING GALLOWAY

**TAMPERE** [ta′mpɛrɛ] (*Swed.* Tammerfors), a manufacturing city and the capital of Häme Province, in southwestern Finland. Located about 100 mi. northwest of Helsinki on the southern shore of Lake Näsijärvi, Tampere is built on the hilly sides of a valley and has straight streets lined with clean, trim buildings. A city hydroelectric plant is powered by the Tammerkoski rapids, where the water flowing between Lake Näsijärvi and Lake Pyhäjärvi drops 54 ft. The city was founded in 1779 but had its great growth after 1819, when the Scottish engineer Finlayson, under a government loan and important special privileges, built there the first cotton mill in Finland. With the development of the wood-pulp process around 1860, the city assumed considerable importance as a paper manufacturing center.

Tampere, the largest industrial city in Finland, and third in population, was the center of activities of the Finnish "Red" Army in the 1918 revolution. The capture of Tampere by the "White" Army under Mannerheim, after a battle lasting from Apr. 3 to 6, 1918, assured the republican character of Finland. During the two Russo-Finnish Wars, 1939-1940 and 1941-1944, the city sustained some damage from bombs. Outstanding for its large factories, Tampere is also noted for its modern St. John's Church (built between 1902 and 1904) with frescoes by Magnus Enckell, for its bridge with sculpture by Väino Aaltonen, and for its Näsilinna Museum. In addition to cotton goods and paper, the city manufactures leather, machines, locomotives, linen, roofing, clothing, and shoes. Tampere has rail connections with all parts of southern Finland and is a center of lake and river boating. Pop. 1951, 101,509. J. E. V.

*Slender palm trees fringe a field of of oil-storage tanks in Tampico, center of Mexico's oil-refining industry.*

G. MYERS FROM GENDREAU

**TAMPICO** [tɑmpi′ko], a Mexican port city on the Gulf of Mexico. Located in the southernmost part of Tamaulipas State, on the Pánuco River, 7 mi. from its mouth, and about 210 mi. northeast of Mexico City, Tampico is Mexico's largest oil center, although the oil fields lie some distance away at Poza Rica. Refineries extend along the southern bank of the Pánuco and process from two thirds to three quarters of all the petroleum produced in Mexico. Besides petroleum, some food products and minerals are shipped from the port; imports include machinery, tools, motor vehicles and parts, metals, chemical products, and textiles.

Tampico is of modern construction, with stone and concrete buildings; it has several beautiful parks and plazas and large residential areas. The climate is usually mild, the maximum summer temperature seldom exceeding 95° F. and the yearly average being about 86° F. The rainfall averages about 40 in. annually. The city is visited regularly by ships from New Orleans and has daily air service to Mexico City, Brownsville, Tex., and other points. It is the terminus of two branches of Mexico's National Railways. While chiefly a commercial city, Tampico attracts sportsmen for its tarpon and sea bass fishing and its hunting.

Tampico existed before Cortes set out on his historic march from the shore at Veracruz in 1519. In 1523, Andrés de Olmos, a Franciscan friar studying Mexican dialects, reached the city and found it in ruins, but through his perseverance the Indians were attracted to the town, and it was gradually rebuilt. During the first twenty years of the twentieth century, exploitation of the oil fields brought a wildcat boom to Tampico, but the oil fever then subsided and the population diminished. Higher prevailing wages maintain a better standard of living in Tampico than in other sections of Mexico. Pop. 1950, 94,342. S. G. I.

**TAM-TAM.** *See* Tom-Tom.

**TANA** or **TSANA** [tɑ′nɑ, tsɑ′nɑ], a lake situated more than a mile above sea level and covering an area of about 1,400 sq. mi. in Begemdir and Gojjam provinces, northwestern Ethiopia. Lake Tana owes its origin to volcanic eruptions that dammed the upper reaches of the Blue Nile, or Abbai, as it is called in Ethiopia. Behind this natural dike, Lake Tana constitutes a vast reservoir for the headwaters of that river. The lake attains a depth of 45 ft. in places. Some of the many islands in the lake are volcanic, and on several of them there are churches, convents, and other religious buildings. The only town on the lake, Bahar Dar, with about 1,000 inhabitants, is situated on the southern shore. Gondar, with a population of 22,000, lies 30 mi. north of the lake.

The existence of Lake Tana was known in ancient times. It was rediscovered in the sixteenth century by the Portuguese, who called it Lake Dembea, and numerous explorers visited it and the Blue Nile during the nineteenth century. In the early twentieth century it was subjected to careful technical study by engineers and cartographers. The control of the headwaters of the Blue Nile, on which Egypt and the Anglo-Egyptian Sudan are dependent, has long been the subject of international negotiations and treaty-making. The British and Egyptian governments, in particular, have shown a marked interest in the various proposals that have been advanced for the construction of a dam at or near the outlet of Lake Tana. R. G. W.

**TANAGER** [tæ′nəjər], any of a large number of small (7 to 8 in.) New World songbirds constituting the family Thraupidae, most nearly allied to the finches. The great majority of them inhabit Central and South America, but a few forms migrate northward in summer to breed in the temperate regions of North America. As a group they are famous for their brilliant or even gaudy plumage, which sometimes combines as many as a half-dozen brilliant hues; some forms are, however, relatively plainly colored. Their bills are too soft to permit them, like the finches, to feed on seeds, and their diet consists, for the most part, of berries and insects. Four species of the genus *Piranga* reach the United States, where they are somewhat retiring dwellers in woodlands. Of these, the hepatic tanager, *P. flava hepatica,* is found only in the southwestern states; better known are the western tanager, *P. ludoviciana,* yellow and black with a red head; the all-red summer tanager, *P. rubra;* and the scarlet tanager, *P. olivacea,* which has an intensely scarlet body and black wings. H. G. De.

**TANAINA.** *See* Indian Tribes, North American (*Western and Eastern Subarctic*).

**TANAKA, BARON GI-ICHI** [tɑnɑkɑ] (1863-1929), Japanese statesman, was born in Yamaguchi in 1863. He graduated from military school in 1886 and rose rapidly in the Japanese army. From 1918 to 1921 he served as minister of war and directed the occupation of eastern Siberia. In 1927, when Japan was in a financial panic, Tanaka was named premier and minister of foreign affairs. He prevented the bankruptcy of the country's large corporations by declaring a bank holiday and by obtaining an important loan for the two major banks.

Tanaka is more widely known, however, for a paper he is believed to have written which outlines a planned imperialistic conquest of China, the Pacific, and finally the world. The Tanaka Memorial, discovered and published in China, was refuted by the Japanese government. Nevertheless, Japan followed the pattern of the Memorial in many subsequent actions. Tanaka himself was forced to resign as premier in 1929 because of repercussions over the death of Manchuria's dictator, Chang Tso-lin, who was believed to have been killed by Japanese troops sent to Manchuria by Tanaka to "protect" Japanese interests and treaty rights. Tanaka died in Tokyo, Sept. 29, 1929, shortly after his resignation. F. G. P.

**TANANA.** *See* Indian Tribes, North American (*Western and Eastern Subarctic*).

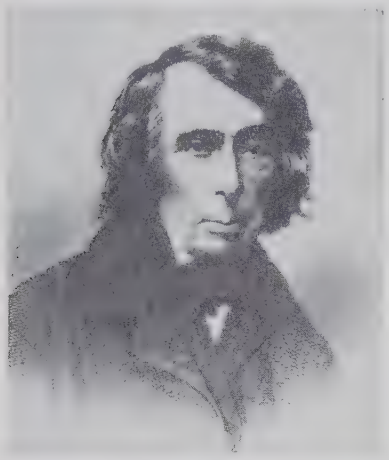
**TANANA RIVER** [tæ′nənə], 475 mi. long, one of the major tributaries of the Yukon River in Alaska. It rises in the glaciers of the Wrangell Mountains, in southeastern Alaska, and follows a winding course generally northwest, flowing into the Yukon at the town of Tanana. Fairbanks, the commercial and population center of interior Alaska, is located on a slough of the Tanana. The Tanana is frozen during the winter, but during the summer it is navigable by river boats for 225 mi. The river valley forms a natural transportation route which is utilized by the Alaska Highway. J. E. F.

**TANANARIVE** or **ANTANANARIVO** [tɑ′nɑ′nɑ′ri′v, ɑ′ntənæ′nəri′vo], the capital of Madagascar, a large overseas island territory of France off the east coast of Africa. The city is situated in the east central part of the island on a high plateau, 4,600 ft. above sea level, at 18° 46′ S. lat. and 47° 30′ E. long. It is about 135 mi. southwest of Tamatave, the principal seaport on the east coast, with which it is connected by railroad. The ancient capital of the Hova kingdom, Tananarive became, after the French conquest in 1895, the seat of the French administration of Madagascar and its dependencies. Pop. (est. 1949), 174,200; 1951, 177,059. W. S. V.

**TANCRED** [tæ′ŋkrɛd; tæ′ŋkrɪd] (c.1075-1112), renowned warrior of the First Crusade, was born in southern Italy about 1075, a grandson of the Norman adventurer Robert Guiscard. In 1096 Tancred set out with his uncle Bohemund I on the First Crusade, and the following year distinguished himself in battle at Nicaea and Dorylaeum. Tancred then advanced over the Taurus Mountains and secured Tarsus, but was driven out by Baldwin of Lorraine. Soon afterwards Tancred rejoined the main army and participated in the siege of Antioch. While Bohemund remained behind, Tancred led the advance guard to Jerusalem. He was conspicuous in the capture of the city and in the defeat of the sultan of Egypt's army before Ascalon, Aug. 12, 1099. He later returned to Antioch as regent for Bohemund, and, on the latter's death in 1111, succeeded to the principality. Tancred himself died a year later on Dec. 5, 1112. His deeds are celebrated in the literature of the Crusades. F. C. H.

**TANEY, ROGER BROOKE** [tɔ′ni] (1777-1864), American jurist, was born in Calvert Co., Md., on Mar. 17, 1777. He graduated from Dickinson College, Carlisle, Pa., in 1795, and studied law at Annapolis, Md., beginning a practice in 1799. That same year he successfully ran for election to the house of delegates as a Federalist. He was defeated for re-election in 1801 and 1803, and moved to Frederick, Md., to resume his legal practice. From 1815 to 1831 he was regarded as one of the outstanding lawyers of Maryland, where he served in the state senate and as attorney general, becoming a Democrat after the break-up of the Federalist Party. In

1831 President Jackson appointed him to the attorney generalship of the United States, and it was in this position that he became a trusted adviser to the president. Two years later he was appointed Secretary of the Treasury in place of William John Duane, who had refused to remove government securities from the Bank of the United States, then seeking a new charter. Taney felt that the bank was already too powerful and removed the securities, an action that was fiercely criticized by the Senate which subsequently refused to confirm his appointment. In 1835 Jackson nominated Taney as associate justice on the Supreme Court bench, but once again the Senate refused the confirmation. In 1836,



ROGER BROOKE TANEY

FROM AN ENGRAVING BY A. H. RITCHIE

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however, the personnel of the Senate had changed and Taney was both nominated and confirmed to the post of Chief Justice of the Supreme Court, succeeding John Marshall, despite continued opposition to him as "Jackson's tool."

Taney is considered one of the really great justices, despite the fact that his decision in the Dred Scott Case helped the cause of slavery. His interpretation of the due process clause was a totally new concept in constitutional law, although the majority opinion in that case declared that slaves, as property, were not entitled to the rights of citizens and therefore could not bring a case before the Federal courts. Taney, himself, emancipated his own slaves. An outstanding jurist, he brought system to the court's procedure, a quality it had lacked under Marshall's leadership. Taney died in Washington, D.C., on Oct. 12, 1864. R. T.

**TANG.** *See* SURGEONFISH, DOCTORFISH, OR TANG.

**TANGANYIKA** [tæŋgənyi′kə; ta′nganyi′kə], a British trust territory in east central Africa, located just south of the equator, bordering the Indian Ocean. It is bounded on the north by the British dependencies of Kenya and Uganda, on the west by the Belgian trust territory of Ruanda Urundi and the Belgian Congo, and on the south by Northern Rhodesia, Nyasaland, and Mozambique. Off the coast are the islands of Pemba and Zanzibar, forming the British protectorate of Zanzibar. Lakes Victoria, Tanganyika, and Nyasa form a considerable part of the northern, western, and southern boundaries, respectively. The area of Tanganyika is 362,674 sq. mi., of which 19,982 sq. mi. are inland water. Prior to World War I, Tanganyika and Ruanda Urundi constituted German East Africa.

**Geographical Features.** *Topography.* Varying from 10 to 40 mi. in width, a low coastal plain extends for almost 500 mi. from the Umba River in the north to the Ruvuma in the south. Farther inland is a wider belt of rugged and rising terrain, beyond which is a great central plateau with an average altitude of almost 4,000 ft. It is the largest single land feature of Tanganyika. To the east and west of the plateau is an outward-facing escarpment, surmounted by broken ranges through which the rivers draining the plateau have cut in order to reach either the Indian Ocean or the western lakes. The biggest rivers breaking through to the east are the Pangani, Wami, Rufiji, and Ruvuma. The major river flowing west is the Malagarasi, which drains into Lake Tanganyika. Lake Victoria (3,720 ft. above sea level) is one of the headwaters of the Nile; Lake Tanganyika (2,534 ft. above sea level) empties westward into the Congo River system; and Lake Nyasa (1,568 ft. above sea level) empties into the Zambezi system. Lakes Tanganyika and Nyasa form part of the great African rift valley. Farther to the east is a secondary rift, neither so regular nor so deep as the great valley to the west, within which are Natron, Manyara, Eyasi, and Rukwa lakes. The northern extension of the rift across Kenya to Lake Rudolph is more clearly marked. Here and there throughout Tanganyika are isolated mountain massifs and broken ranges, mostly of volcanic origin. On the northern boundary is Africa's highest mountain, Kilimanjaro (19,565 ft.), flanked on the west by another volcano, Mount Meru (14,980 ft.), and on the southeast by the Usumbara Mountains. To the north of Lake Nyasa are several broken ranges, such as the Kipengere, which has altitudes of over 8,000 ft.

*Climate.* The rainy season extends from late November to early May. Toward the western lakes this season is divided into the early or long rains and the later or short rains, separated by an interval of relative dryness. Except on exposed mountain slopes, the western region has the highest precipitation, the annual average being above 70 in. The low coastal area has almost as much rain, averaging about 60 in. at Dar es Salaam. On the central plateau the average hardly reaches 30 in., though it is a little heavier in the rugged country between the plateau and the coastal plain. Deviation from the average tends to increase with altitude so that drought becomes a major agricultural hazard on the plateau.

*Flora.* Differences in temperature, largely owing to elevation, and variations in rainfall exert the strongest influence on the natural vegetation. Except near the western lakes and in the river valley flood plains, there is little dense tropical forest. The plant cover on the plateau ranges from savanna to park land. Predominant among the plants are the grasses, which are coarse along the coast but finer and more nutritious on the plateau. On much of the plateau, however, heavy drainage and other unfavorable circumstances sustain thorny, xerophilous shrubs over the grasses. The dominant trees on the coastal plain are the native mango and the imported coconut and mango. On the shoulders of the higher mountains the conifers become important, especially cedar and podo. Although not the most prevalent tree in the park land, the most useful is the mninga (*Pterocarpus angolensis*), which is highly valued in construction for its appearance and durability. The most valuable hardwoods, including mahogany, are found in the denser tropical forests near Lake Victoria and on the lower eastern slopes of the mountains.

*Fauna.* Several species of antelope, and also the lion, leopard, zebra, elephant, and giraffe, inhabit the open uplands. Monkeys are plentiful, but among the apes only the chimpanzee is found, and it only in the extreme northwest. Both the hippopotamus and crocodile live along the rivers. Among birds the most numerous are swimmers and waders. The ostrich has not quite disappeared from the uplands. Among

RUNE HASSNER FROM BLACK STAR

*Goat herders tending their flocks on the dusty upland plains of Tanganyika, in east central Africa*

poisonous snakes are the black mamba and puff adder. Much of the territory is infested with tsetse flies, mosquitoes, ticks, and locusts.

**Population.** Almost 99 per cent of the population is indigenous and basically Negro, with some Hamitic infiltrations in the north. Most of the Africans, especially in the interior, still retain their pagan beliefs and their ancient tribal practices. Some of the 120 tribes number only a few thousand each, others several hundred thousand. The largest is the Sukuma of the lake province, which has 51 chiefdoms and almost a million members. Other large tribes are the Nyamwezi, Gogo, and Chagga. The pastoral Masai on the Kenya border are predominantly Hamitic in speech and race. Most of the tribes speak variants of Bantu, but the dialects are so distinct that intertribal communication is usually difficult and often impossible. Swahili, a mongrel tongue composed principally of Arabic and Bantu, is the lingua franca throughout the territory, exclusively used along most of the coast and by many in the inland trading centers.

Tanganyika's population was estimated at 8,069,300 in 1953. This included 7,965,000 Africans, 20,300 Europeans, and 84,000 other non-Africans, mainly Asians. The African population has rapidly increased, having risen from 5,545,450 in 1945. The principal cities, with their populations at the 1952 census, are: Dar es Salaam, 99,140; Tanga, 22,136; Tabora, 14,011; and Mwanza, 13,691.

**Government.** *Administration.* At the head of the administration is a governor appointed by and responsible to the British Colonial Office. He is assisted by an executive and a legislative council. Acting under a United Nations trusteeship agreement, the British administration is also responsible to the U.N., submitting annual reports to the international body and opening the territory to periodic visits by U.N. inspection missions. A new constitution put into effect in 1955 provided for an enlarged legislative council of 61 members, including 31 official government members and 30 unofficial nominated members. The unofficial membership was divided equally among the territory's three cultural groups—10 Europeans, 10 Asians, and 10 Africans—in a new "parity" formula put into practice for the first time in the British East African possessions. For local administration Tanganyika is divided into 8 provinces, then subdivided into districts. Provincial and district commissioners supervise local government. In 1949 the first provincial council was established for the Lake province, and one for the Southern Highlands province in 1950. Officially authorized native authorities are being increasingly used in both administrative and judicial functions. The largest of these is the Sukumaland federation established in 1946. It is the policy of the government to encourage chiefdoms to assume responsibility and thus promote self-government on a local level without destroying tribal cohesion and mores. In 1949 Dar es Salaam was granted municipal status and a considerable measure of self-control.

*Currency and Public Finance.* The only legal tender in Tanganyika is the East African shilling, which remains at par with the British shilling. Prior to September 1949 it had a value in United States currency of 20 cents; since then 14 cents. The total revenue for the fiscal year 1953 was £14,727,895; expenditures were £14,724,489.

**Economic Activities.** *Agriculture.* In 1953 there were an estimated 14,000,000 acres, out of a total of almost 220,000,000 acres, under cultivation. The crops, most of which are tilled for local consumption, include maize, millet, sorghum, cassava, and sweet potatoes. The leading export crops are sisal, pyrethrum, cotton, copra, tea, rice, peanuts, bananas, and coffee.

*Livestock.* The area of actual pasture land is officially estimated at about 43,000,000 acres. The chief animals raised are cattle (6,605,300 head in 1953), goats (3,670,400), sheep (2,783,400), and donkeys. Cattle, the major breeds of which are the zebu and Ankoli, are regarded as the primary form of wealth among the indigenous population. European breeds, principally for dairy products, are raised by non-Africans. There is some interbreeding with native cattle.

*Mining.* The most important mineral products are diamonds and gold. The Shinyanga district of Lake province is the principal diamond center, where valuable discoveries were

C. TRIESCHMANN FROM BLACK STAR

*A clock tower of simple design occupies the center of the public square at Arusha, in northeastern Tanganyika.*

made in 1940. The territory's allocation of diamond production is one tenth of world production, and in 1953 amounted to 170,679 carats worth £2,100,000. Gold, which in 1953 totaled 69,886 troy oz. of refined bullion valued at £903,993, is widely distributed, but the main center is in the southern Chunya district in Southern Highlands. Other minerals include sheet mica, tin, and salt. Still in the development stage are coal, iron, kaolin, tungsten, lead, and silver. Considerable amounts of lime and building stone are produced for local use. Surveys of promising coal and iron deposits on either side of the Ruhuhu Valley near Lake Nyasa are being actively conducted, and the exploitation of lead deposits at Mpanda, in the west, will be greatly aided by the railway recently constructed into that area.

*Transportation.* The railways, now under the East African Railways and Harbours Administration, are all of meter gauge and totaled about 1,500 mi. in 1950. More than 16,000 mi. of roads, chiefly suitable for light traffic during the dry season, are maintained by the central or provincial governments. The Great North Road, which links the Union of South Africa with Egypt, passes through the territory. The East African Railways maintains steamer service on Lakes Victoria and Tanganyika, and the Nyasaland Railways on Lake Nyasa. The East African Airways connects the main centers of Tanganyika with those of Uganda, Kenya, Nyasaland, and Zanzibar. At Dar es Salaam and Nairobi, capital of Kenya, connections are also made with British Overseas Airways and other intercontinental services.

*External Trade.* The total value of domestic exports in 1953 was £34,545,000. Less than half was accounted for by the export of sisal hemp and tow valued at £12,773,000. Other items of domestic export are coffee, raw cotton, diamonds, gold, sheep and goat skins, crude papain (papaw extract), pulse, timber and lumber, rice and other grains, leopard skins, beeswax, peanuts, fish, and tobacco. Total value of imports for domestic consumption was £28,427,000; of the total, textiles and clothing accounted for £4,703,000. Imported vehicles and their parts, including railway rolling stock, ships, and aircraft, were valued at £7,468,000. Other imports are electrical goods and machinery, galvanized sheets and other iron and steel manufactures, cigarettes, petroleum products, oils and fats, tools and instruments, cement, and tires and tubes.

**Social and Cultural Activities.** *Education.* The primitive character of much of the life in Tanganyika has resulted in, as well as contributed toward, the backwardness of its educational institutions. Arab Koranic schools made almost as little impression on the life of the country as those of the Portuguese Jesuits. The German government was content to leave education to the missionaries and actively opposed Islamic instruction. The British government was at first disposed only to supply the mission schools with some supervision and small grants in aid, but by 1953 the educational budget had grown to £3,198,690, five times the 1948 figure. Besides primary and secondary schools there are industrial and vocational schools. Enrollment in all schools is small. Higher educational facilities do not exist in Tanganyika, but are available in Uganda and Kenya. Students attending these institutions, as well as those registered in British universities, receive government assistance.

In the curriculum of African primary schools in Tanganyika, Swahili is the medium of instruction. Teaching of English is begun in the fifth year and becomes the language of instruction in secondary schools. In Asian schools, Gujarati or Urdu is used in the primary and English in the secondary grades. European primary schools must teach English, but it need not be the language of instruction. There are no European secondary schools.

**History.** The coast of Tanganyika has been known to the outside world for more than twenty centuries, the interior for hardly more than one. The Greeks knew the coast well, but their maritime enterprise was gradually smothered by Roman land imperialism in which East Africa had no place. Eventually the Arabs became heir to the Greeks, and following the rise of Islam they not only gained a dominance along the coast but established trading colonies. In the tenth century they were supplanted by the Persians, but when the Portuguese explorer Vasco da Gama reached the coast in 1498 the Arabs had for centuries again been in control. Sporadically attacked by Turks, Arabs, English, and Dutch, the Portuguese hold on this part of the African coast had begun to weaken by the end of the sixteenth century, and by the end of the seventeenth the Arabs were back in force. The economic foundation of their East African empire remained the slave trade until the collapse of their power in the second half of the nineteenth century. Ujiji, on Lake Tanganyika, and Tabora, on the plateau, were important inland stations; Kilwa, Lindi, Dar es Salaam, and Pangani were major coastal settlements. The sultan of Muscat claimed overlordship throughout, but local Arab sheiks often paid only slight heed to his commands. In 1832 Said, Sultan of Muscat, transferred his headquarters to Zanzibar, and in 1856 Zanzibar became a separate sultanate. In the same year two British explorers, Sir Richard Francis Burton and John Hanning Speke, entered the territory, and were soon followed by Livingstone and Stanley. The separation of Zanzibar (to which the coastal area was attached) from Muscat caused an intensification of the slave trade just as the first missionaries were attempting permanent establishments. Missionary appeals to the conscience of the Western world served to bring East Africa vividly to public attention.

In 1884 a German promoter, Karl Peters, concluded several treaties with inland chiefs and in the following year was successful in securing a German protectorate over the country, which received the name of German East Africa. Spo-

radic native uprisings followed, the last and most serious being in the south in 1905. The German government came to regard this colony as its most promising dependency, but economic development proved expensive and Germany undoubtedly expended more than it earned in promotion of the colony. Just before the outbreak of World War I the German Central Railway was completed across the country from Dar es Salaam to Kigoma on Lake Tanganyika, and the Tanga line near the Kenyan border was opened. So well trained and equipped was Germany's native African army that, despite the blockade of the coast, General von Lettow-Vorbeck was able to keep the field until after the signing of the armistice. All of German East Africa, except the districts of Ruanda and Urundi, was mandated to Great Britain following the war, and the mandatory system was formally inaugurated in 1922 under the name Tanganyika.

In 1923 the customs schedules of Tanganyika, Uganda, and Kenya were assimilated, and the three customs establishments were amalgamated in 1949. A legislative council was set up in 1926 with 13 official and not more than 10 unofficial members. In 1945 the ratio of official to unofficial was changed in favor of the latter to 15 official and 14 unofficial members, of whom 4 by 1948 were native Africans. In 1926 the annual governors' conference, including Tanganyika, Uganda, and Kenya, was formally established, and in 1948 the interterritorial organization was inaugurated. The transportation services of the three territories were fully amalgamated in 1948. In 1946 Tanganyika became a trust territory for whose administration Great Britain is responsible to the United Nations. Although Tanganyika's population is more primitive and politically undeveloped than either the Kikuyu tribe of Kenya or the Baganda of Uganda, the trusteeship system has led to increased pressure for greater self-government in the territory. After touring Tanganyika in 1954, a U.N. visiting mission proposed the setting of a target date for autonomy. Britain opposed the concept of a timetable, but pledged itself to continued leadership toward self-government. *See also* BRITISH EAST AFRICA. W. M. W.

**TANGANYIKA,** a lake in eastern central Africa, the longest fresh water lake in the world. It is 450 mi. long, 30 to 45 mi. wide, and has an area of 12,700 sq. mi. With a depth of 4,708 ft. and its floor dropping to 2,172 ft. below sea level, it is also the deepest fresh water lake in the world after Lake Baykal in Siberia. Lake Tanganyika lies between the Belgian Congo, Tanganyika, and Northern Rhodesia. The Russisi River enters it at the north, and the Malagarasi is the largest of many feeder streams. The water level often changes because of rainfall fluctuations. Surrounding forest vegetation is luxuriant, and the fertile soil produces rice, maize, manioc, sweet potatoes, and sugar cane. Bantu tribes dwell around the lake, which was circumnavigated by Stanley in 1876. Chief towns are Ujiji and Usumbura.
S. Van. V.

**TANGELO** [ta′njəlo], a group of hybrids made between the mandarin orange, *Citrus reticulata,* and the grapefruit, *C. paradisi,* or the closely similar pummelo (or shaddock), *C. grandis.* The resulting fruits more closely resemble the orange and are rich in color and flavor, excellent for juice and marmalade, but too delicate to be shipped satisfactorily.
C. H. Wo.

**TANGERINE,** a small reddish-yellow citrus fruit, *Citrus reticulata* or *C. nobilis deliciosa.* It is smaller than the orange, oblate in form; it has an easily separable rind and a sweet pulp. The tangerine, known as the kid-glove orange, is produced in the Orient and in the United States. C. R. Eb.

ROSS MADDEN FROM BLACK STAR

*A well-traveled stone staircase descends to the shopping district in Tangier, internationalized seaport in northwestern Morocco.*

**TANGIER** [tanji′r], an international zone including the seaport city of the same name, situated in Morocco in the extreme northwestern corner of Africa. The zone is bordered by the Atlantic Ocean, at the western end of the Strait of Gibraltar, and is surrounded by Spanish Morocco on the landward side. It has an area of 147 sq. mi. and in 1953 had a population of 157,000. The city of Tangier had a 1953 population of 90,000.

Rising in tiers from the Bay of Tangier, the city, which is about 220 mi. northeast of Casablanca, culminates in two hills. It was formerly a walled town, and some sections of the ramparts still exist, but surrounding the old Moorish nucleus are several new European quarters which have been built in conformity with the prevailing Mediterranean style. Seen from the sea, Tangier presents a white and gleaming aspect. After World War II it became a haven for refugees from various parts of Europe, as well as for business enterprises seeking to take advantage of the favorable laws of Tangier.

The harbor has been improved by dredging and breakwaters, but it still accommodates only small ships. Since the establishment of the French protectorate in Morocco, Casablanca has absorbed much of the trade that Tangier had hoped to acquire, a situation altered only slightly by the completion of the Tangier-Fez Railway in 1928. Tangier is a trading and fishing center of local importance, and certain small factories are in operation. In addition to the railway, Tangier is connected by good highways with the French and Spanish zones.

**History and Government.** The ancient Roman city of Tingis was located near present-day Tangier. It fell successively under Vandal, Byzantine, and finally Arab rule at the end of the seventh century. It remained under Arab control until, after several abortive attempts, Portugal captured it in 1471. The area was subject to Spain from 1580 until 1656. Returned to Portugal, it was ceded six years later to England as part of the dowry of the King of Portugal's sister, Catherine of Braganza, who married Charles II of England. In 1684, however, the English decided that they no longer wanted to have the expense of defending Tangier against the

Sultan of Morocco, and allowed the Moors to take possession of the city.

When the Moroccan situation became a matter of general concern and action at the beginning of the twentieth century, the status of Tangier presented a particularly knotty problem because of its strategic location. In the Moroccan agreements of 1904, involving Great Britain, France, and Spain, a separate settlement for Tangier was anticipated. France and Spain determined the boundaries for the Tangier Zone in 1912, but the convention setting up the regime for this territory, negotiated by Great Britain, France, and Spain in 1914, was never put in force because of the failure on Spain's part to sign it. Negotiations were resumed in 1923, and on December 18 Great Britain and France signed an agreement creating for Tangier a new regime to which Spain adhered in February 1924. The statute was formally put into operation in June 1925, and modifications were introduced at the Tangier Convention of 1928. Among other provisions, Italy was accorded participation in the international administration, and Spain was given a larger share. None of these arrangements, however, could revive the city's economic life.

FPG

*A native of Tangier, hooded against the strength of the afternoon sun, bargaining for a roll of colorfully patterned matting in the open-air market of Zoco Grande*

In June 1940 Spanish Khalifan troops invaded the Tangier Zone, ousted most of the international agencies governing it, and placed the territory under the rule of the Spanish High Commissioner for Morocco. Later, steps were taken to achieve virtual annexation of the Tangier Zone to Spanish Morocco.

With the end of World War II in Europe, a conference of French, British, United States, and Russian representatives, meeting at Paris in 1945, agreed on the establishment of a regime in Tangier based on the 1923 convention, and on Oct. 11, 1945, international rule was restored. The Tangier Zone is demilitarized. *See also* Morocco.

R. G. W. and W. W. W.

**TANGO** [tæ′ŋgo], a leisurely, measured ballroom dance in duple meter executed by couples and characterized by the rhythm ♩.♪ ♩♪, against which the melody is often syncopated. The tango first appeared about 1900 among dock hands and other slum dwellers in Buenos Aires and elsewhere around the mouth of the La Plata River. Most of these people were migrant West Indian and Central American Negroes, and it seems evident that the tango developed out of earlier and very similar West Indian dances, such as the habanera and the tangano, from the latter of which the tango may have inherited its name. By about 1910 the tango was a favorite in Argentine ballrooms, and within a decade it had become popular in Europe and, to a lesser degree, in North America, although not without opposition from churchmen and purists, who objected to its suggestive movements. Among Europeans the melancholy music and unhurried elegance of the tango, although they have now become somewhat refined and stylized, have made it a leading ballroom dance, but in North America it has never lost its exotic flavor and remains largely an exhibition dance. During the 1920's especially, European composers were fond of introducing stylized tangos into art music.

The Spanish tango, a fiery solo dance of the flamenco type, belonging rather to the Spanish gypsies than to true Spaniards, seems to have nothing in common with the Argentine tango described above save the coincidence of name. P. N.

**TANGUT.** *See* Asiatic Tribes (*Sinitic*).

**TANJORE** [tanjo′r], the chief city in a district of the same name in southeastern India. The city is located in southeastern Madras State on the southernmost distributary of the Cauvery River at 10° 47′ N. lat. and 79° 10′ E. long. It is near the western edge of a fertile plain in the Cauvery Delta, about 60 mi. west of Negapatam, a port on the Bay of Bengal. The city receives from 30 to 50 in. of rain annually, most of which falls during the winter, December having from 5 to 10 in. High temperatures prevail throughout the year. The dry summer, and fluctuation in the amount of winter rain, made agriculture precarious and famine common until the Mettur Dam was built on the upper Cauvery River to provide irrigation by way of more than 3,500 mi. of canals and ditches in the area. Rice is the major crop and some millet, sesame, tobacco, and sugar cane are grown. In addition to being an administrative, agricultural, and railroad center, Tanjore is known for its manufacture of jewelry, carpets, and metal ware. A Dravidian temple, built in a pyramidal form with many carvings and sculptures and enclosed by an old fort, attracts visitors as does an old palace, also within the fort. The city was the administrative center of the Chola Kingdom during the eleventh century, was captured by the Marathas in 1674 and then by the French, who relinquished it to the British in 1855. Tanjore remained part of British India until 1947, when it became a part of the dominion of India. Pop. 1951, 100,680. J. E. F.

**TANKS.** Tanks are armored motor vehicles mounting armament and intended primarily for offensive combat. The tank is a self-propelled vehicle of the track-laying type, with its main armament usually mounted in a turret with full traverse, and with armor designed to give over-all protection for crew, armament, and power plant against enemy fire.

Tanks are classed according to their use and weight as light, medium, and heavy tanks. In the light tank, intended for reconnaissance and for operation against enemy troops, mobility is emphasized. The designation "light" is relative, and the light tank in production for the United States Army at the end of World War II was as heavy as the medium tank of 1939 and mounted a heavier gun. The medium tank is a vehicle designed to combine mobility and firepower. It carries firepower to cope with enemy tanks and centers of resistance, armor to afford protection against medium caliber fire, and has mobility to exploit thoroughly

penetration of the enemy's line of resistance. In the heavy tank the major emphasis is upon firepower and protection, with mobility a secondary consideration. It is an assault vehicle, designed to absorb and deflect enemy fire.

The policy of the United States following World War II called for a light tank to be used by armored regiments (light) and by divisional reconnaissance squadrons; a very light tank, air transportable, for airborne troops; a medium tank for the tank battalions of infantry and armored divisions, and for the tank companies of infantry regiments; and various types of special tanks, as described below. The development of a new heavy tank was delayed in hope that new anti-tank weapons would make heavy tanks obsolete.

**U. S. Army Tanks.** At the end of World War II, the standard United States Army light tank was the M24, a vehicle weighing about 20 tons, carrying, as main armament, the 75-mm. gun, turret mounted, powered by two V-8, liquid-cooled engines, with torsion bar suspension, and armor of 1 in. thickness. Also standard was Light Tank, M22, an airborne tank weighing about eight tons with a 37-mm. gun as main armament. In World War II light tanks carried crews of four men and had a cross-country speed of about 25 m.p.h. Their chief use was as speedy reconnaissance vehicles in the North African, European, and Pacific campaigns. In 1952 the new "Walker Bulldog" light tank, M-41, was coming into service; it weighs 26 tons and carries a 76-mm. gun.

In World War II, the Medium Tank, M3, was developed. It was a vehicle weighing about 31 tons, with main armament of a 75-mm. gun, sponson mounted with limited traverse. Auxiliary armament was a 37-mm. gun, turret mounted, and .30 caliber machine guns, with a maximum armor thickness of 2 in. upper front hull and 2¼ in. on the turret. The vehicle was powered by a 9-cylinder, air-cooled radial engine. Turret and sponson were cast, and the hull was of riveted construction. Because of its superior firepower the M3, while an expedient pending development of a tank carrying main armament turret mounted, was highly successful in the North African theatre. The M3 was succeeded by the Medium Tank, M4, the Sherman tank. This vehicle used the chassis of the M3, with power plant and power train, weighed about 31 tons, had as main armament the 75-mm. gun, turret mounted, and had a maximum armor thickness of two inches on frontal hull surfaces and of three inches on the turret front. The M4 series of medium tanks was the backbone and principal combat vehicle of the Armored Force. In World War II they were used in assault as supporting artillery for troops.

The Pershing (M-26) 45-ton tank carrying a 90-mm. gun came into limited use late in the war, and afterward was for a time the standard United States medium tank. In Korea, however, the M-26 proved to be underpowered for operations on difficult terrain. The Patton medium tanks—M-46, M-47, and M-48—became, after 1950, the backbone of the United States armored forces. The latest of these, the M-48, weighs between 45 and 50 tons, is armed with a 90-mm. gun and 3 machine guns, has an 810-hp. V-12 air-cooled engine and a cross-drive transmission, and carries a crew of four men. A heavy tank (T-23), armed with a 120-mm. gun but weighing very little more than the Patton, was under test in 1952.

Special-purpose tanks include the following types: (a) the flail tank, equipped with mechanical devices for beating the ground in front of the tank for the purpose of exploding land mines in the tank's path, and also for smashing barbed wire entanglements; (b) the flame-thrower tank, for reaching enemy personnel in caves and other deep shelters; (c) the fascine tank, equipped to carry bundles of brushwood to fill up anti-tank ditches; usually used in connection with an armored bull-dozer, which shovels earth on top of the fascines to make a causeway across the ditch; (d) the bobbin tank, which carries a huge reel of reinforced coir matting which unrolls underneath the tank and thus makes a path over soft ground on which other tanks and vehicles can follow; (e) the ramp tank, called the Ark by the British, which has ramps fore and aft by which ditches or sea-walls may be crossed; (f) the bridge tank, carrying a long bridge-section capable of spanning a small stream; and (g) amphibious tanks with propellers as well as tracks, for use in connection with landing operations.

U. S. SIGNAL CORPS PHOTO

*The M4 Sherman tank, developed in World War II as a standard unit of infantry attack*

**Armored Artillery.** During World War II, the United States Army developed various types of self-propelled guns, both for attacking hostile armor and supporting its own. These were often called "tank destroyers." Since the war, standardized types of self-propelled armored artillery have been developed for assignment to armored divisions.

**British Tanks.** The British Army has pioneered in tank design. During the later phases of World War II, however, the Royal Armoured Corps used tanks mainly of American manufacture. One notable British tank was the "Churchill," a large tank carrying a turret-mounted 6-pounder gun and 2 machine guns, used chiefly for close support of infantry. The postwar British medium tank is the "Centurion," a 50-ton tank with a 635-hp. Rolls Royce engine, mounting an 85-mm. gun. This tank has operated with notable success in Korea with the British Commonwealth Division and, in 1952, formed the basic armament of the three British armored divisions stationed in Germany.

**Russian Tanks.** The best-known modern Soviet tanks are the medium T-34, weighing 37 tons, very heavily armored (especially in front), and carrying either a 76-mm. or an 85-mm. high velocity gun, and the heavy "Josef Stalin" tank, a 50-tonner armed with a 122-mm. gun. Earlier models of the Stalin tank weighed as much as 57 tons. H. W. E.

**TANNA** [tɑ′nɑ] (pl. tannaim), an Aramaic term meaning "teacher" and designating the early Talmudic sages who flourished in Palestine in the first two centuries of the Christian Era. Traditionally, they were the successors of the sopherim (scribes) in transmitting the Oral Law to posterity. The teachings of the tannaim are found primarily in the Mishnah, a compilation of laws constituting part of the Talmud; but they are also found in the midrashim (rabbinical exegetical works) and in the tosephta and the baraithas (bodies

of legal material, Mishnaic in character, but excluded from the Mishnah). The tannaim, of whom more than 200 are known by name, are divided into six consecutive groups, or generations, who flourished in the following approximate periods: A.D. 10-80, 80-120, 120-140, 140-165, 165-200, and 200-220. They were addressed by the title rabbi, or some, by reason of their distinction, by the even more respectful title rabban. Not all tannaitic quotations bear the names of their authors, but in many cases authorship may be established by comparison with a text of known authorship. *See also* MISHNAH; TALMUD. M. A. G.

**TANNENBERG, BATTLES OF** [tɑ′nənbɛrχ], two famous battles, five hundred years apart, both of which had important results. The first, sometimes called Grünwald, was fought July 15, 1410, between a Polish army allied with a smaller force of Lithuanians, and commanded by King Ladislas II of Poland, and the Order of the Teutonic Knights. It resulted in a crushing defeat for the Knights and marked a definite beginning of the end of their expansion and power. The Order never recovered from the defeat. The second battle, one of the early and decisive engagements of World War I, was fought on the eastern front between German and Russian troops, Aug. 26-29, 1914. The defeat of the Russians was so disastrous that any further threat to East Prussia was temporarily removed. The Battle of Tannenberg ended any imminent danger of Russian invasion of Germany. It nullified the Russian gains in Galicia and enabled Germany to turn once more to the western front. M. K.

**TANNHÄUSER** [tɑ′nhɔizər], an opera in three acts by Richard Wagner, who based his libretto on medieval Germanic legends. It was first performed on Oct. 19, 1845, in Dresden and was revised to its present form for a production in Paris in 1861. In this work Wagner began to extend his use of musical motives to underline or comment upon the action, and for the first time he adopted the vocal style which he called *sprechgesang,* or speech-song, a highly dramatic free declamation which breaks now and then into lyric melody. In this style the distinction between aria and recitative has been broken down and only the long line of purely expressive speech-melody is heard. Wagner also began, in this opera, to assign a more important role to the orchestra, the expressiveness of which was enormously extended by the increased number of instruments he demanded. Musicians, even the performing artists, were puzzled or repelled by the new style, but a few adherents, who were for the most part not musicians, were so strongly drawn to Wagner's ideas that it is possible at this time to perceive the beginnings of what later became the Wagner cult.

The story of the opera is set in thirteenth-century Thuringia and borrows the name of the historical Tannhäuser, who was a minnesinger. The Tannhäuser of the opera (tenor) is a medieval knight who has found his way to the Venusberg, where he now lives with Venus (soprano). He becomes weary of sensual love, however, and returns to his friends in the world of men. When he tells of his experiences, he is regarded with horror and is urged to join a group of pilgrims and seek absolution at Rome for the sin of profane love. This is at first refused him, but the unselfish devotion of the Lady Elizabeth (soprano) finally obtains him forgiveness. S. C.

**TANNING.** *See* LEATHER.

**TANNINS** [tæ′nɪnz], a large class of substances found in plants and in barks of certain trees. They precipitate gelatin solutions, tan hides, and form bluish-black color combinations when in contact with ferric salt solutions. For tanning purposes water extracts of gall nuts and of such barks as oak, wattle, and hemlock are employed. The color produced upon the addition of solutions of iron salts has made the tannins useful in the manufacture of certain inks and bluings. The chemistry of the tannins is known to a considerable degree. They are all derivatives of aromatic acids and contain polyhydric phenol structures. Some of the simpler tannins have been synthesized in the laboratory. *See also* LEATHER. E. H. Co.

**TANNU TUVA.** *See* TUVA AUTONOMOUS OBLAST (REGION).

**TAN OAK,** a tree, *Lithocarpus densiflora,* of California and southern Oregon, sometimes 150 ft. high, closely related to the oak. All of the other 100 species of *Lithocarpus* are confined to southeastern Asia. W. D. B.

**TANSY** [tɑ′nzi], strong-scented herbs, *Tanacetum,* of the family Compositae, distributed throughout the Northern Hemisphere and comprising 35 species, of which 7 are native to North America. They bear alternate leaves and heads of

THOMÉ - DR. LASCOFF

*The common tansy,* Tanacetum vulgare, *showing detail of root, seed, flower and leaf*

small to medium-sized yellow flowers. The common tansy, *T. vulgare,* native in Europe, is grown extensively throughout North America in old gardens, from which it has escaped to roadsides and waste places. It is a perennial about 3 ft. high, bearing deeply cut aromatic leaves and dense clusters of small yellow flower-heads in midsummer. It was formerly widely in use in a dried form for seasoning and medicinal purposes, and is still sometimes employed as a household remedy for rheumatism and bruises. E. R. C.

**TANTA** [tɒ′ntɒ], a city in northern Egypt, situated in the center of the Nile Delta, about 60 mi. northwest of Cairo. It is the capital of the province of Gharbiya. As the chief railway center in the Delta, it is connected with Alexandria,

Cairo, Mansura, and Damietta. Tanta is famous for the mosque containing the tomb of Ahmed al-Bedawi (c. 1200-1276), Egypt's greatest Moslem saint. There is a branch of Cairo's al-Azhar University here. Pop. 1947, 139,926.

W. S. V.

**TANTALUM** [ta′ntələm], symbol Ta, atomic number 73, at. wt. 180.88, density 16.6, m.p, 2,996° C., b.p. over 4,100° C. Tantalum (its name a Latin derivative from the Tantalus of Greek mythology) is a transition metal in Group V-A in the periodic table, closely related to columbium, and less closely to vanadium. The principal source of tantalum is iron tantalate, $Fe(TaO_3)_2$, frequently associated with columbite. Tantalum is a white metal, remarkably ductile, malleable, strong, and tough. It resists the action of acids, including aqua regia, but is dissolved by a mixture of nitric acid and hydrofluoric acids. With fused alkalies it forms tantalates, such as $K_8Ta_6O_{19}$, soluble in water and hydrolyzed by boiling. Tantalum metal is used to make dental and surgical instruments, corrosion resistant equipment of many sorts, electrodes, rectifiers, pens, and standard weights. It is almost indispensable in constructive surgery. B. S. H.

**TANTALUS** [ta′ntələs], in Greek mythology, a king of Sipylus in Lydia (or of Phrygia), the son of Zeus and father of Pelops. He was admitted to Olympus by Zeus but abused the friendship of the gods. His crime is variously reported: (1) he attempted to deceive the gods by serving them at a banquet the flesh of his son Pelops; (2) he stole their nectar and ambrosia; (3) he divulged the secrets of the gods; or (4) he denied knowledge of a golden dog stolen from the shrine of Zeus. His punishment in Tartarus was proverbial and has given rise to the English verb "tantalize." Parched with thirst, he stood in a pool with water to his chin, but the water always receded as he tried to drink; over his head were fruits which the winds moved away as he tried to grasp them. *See also* Pelops. G. E. D.

**TANTU.** *See* Chinkiang.

**TAOISM** [dau′izəm], two radically different Chinese movements—on the one hand, a philosophy, on the other, a positive religion. Philosophic Taoism has exalted mysticism, naturalness, and simplicity, the securing of solace in misfortune by the cultivation of inward calm, *laissez faire,* optimism, and skepticism of doctrinaire programs.

Religious Taoism probably developed out of much older elements during the fifth and subsequent centuries of the Christian Era, and it was encouraged as a native religion in order to compete with foreign Buddhism. The founder of Taoism is traditionally considered to have been Jang Ling (or Chang Tao-ling) of the second century of the Christian Era. The present chief Taoist priest and magician claims descent from him and calls himself by his ancestor's title, the *Tien-shzh* ("Heaven's Apostle"). Early accounts of Jang Ling's teachings indicate, however, that he taught the Persian Mazdaism of the Later Avesta. He cured diseases by having his patients confess their sins and pray to three high gods: Heaven (probably Mithra), Earth, and Water (probably Anahita). The Mazdean supreme God, Ahura Mazda, was in Persia called *"Dadhvah,"* the "Creator," which was translated by the Chinese word *"Tao."* Members of this Chinese cult worshiped *Tao* as a personal God. Zoroaster's name for the highest heaven, *"Garo-dman,"* became the Chinese *"Ta-lo."* The location of Jang Ling's fire temple on a hill north of the present Chengtu, Szechwan, is still shown; he organized a hierarchy of priests and emphasized the position of angels and of purity, both prominent in Mazdaism. Chinese bronze mirrors of the first four centuries of the Christian Era, which are commonly said to represent "Taoistic divinities and dragons," are probably charms of this cult. It spread to the imperial court and thence to the Yangtze delta, where it became important, securing the allegiance of prominent ministers and officials. A rebellion led by Taoists in 399-410 resulted in its drastic suppression.

"Gentlemen of the *Tao* (*Tao-shzh*)," such as Kou Chien-jzh, took over the cult's remnants in 415 and united them with other Chinese and Buddhistic elements to produce religious Taoism. Among these elements was alchemy, which probably originated with Dzou Yen, and which promised the prolongation of life through the elixir of immortality, made from alchemical gold. Dietary practices were also added, especially the avoidance of grain and the eating of magical mushrooms and minerals. Prolonged meditation and control of the breath were cultivated, as was communication with immortals (*sien*) and other supernatural beings. This cult had attached itself to the Lao-tse, but not to Juang-tse. During the second millennium of the Christian Era, physical alchemy became an esoteric spiritual alchemy, using such terms as sulphur, mercury, and gold to denote special bending and stretching exercises, massage, mental self-control, cultivation of calmness, acceptance of the inevitable, and the mystical ecstasy.

Contact with Buddhism added other details to Taoism, of which the most important were monasteries and temples. Ancient hermits and immortals became gods, and were worshiped for their favors. Planets, stars, ancient heroes, human activities, even robbery, fornication, and drunkenness, beasts and insects, such as grasshoppers, snakes, tigers, and dragons, were honored as minor divinities. The "Three Stars" of Happiness, of Emolument, and of Longevity, together with the "Eight Immortals" are mostly literary and symbolic figures, for they are rarely worshiped. Ancient Chinese gods were added to the Taoistic pantheon, such as the God of the Eastern Sacred Mountain (Mount Tai), who acts as the divine ruler of China; Guan Yü, an ancient hero who became god of war; and the Mother Queen of the West (*Si-wang-mu*), who rules the terrestial heaven on the Kun-lun Mountains and raises the peaches of immortality. Jang Ling's triad of Heaven, Earth, and Water was continued. And at the head of this pantheon was placed the Jade Emperor (*Yü-huang Shang-di*), a god first mentioned in the ninth century. Since Jade denotes purity, the Jade Emperor was probably a new designation for Jang Ling's God, Tao.

An important Taoistic doctrine is that good and evil deeds are duly repaid. The *Book on Responses* ("rewards & punishments") *Evoked by Good and Evil Deeds* (*Gan-ying-pien*) is perhaps the most popular Taoist tract. According to this work, the kitchen God (*Dzao-shen*) and guardian spirits watch individuals and report their deeds to the Jade Emperor or other gods; and the god of the Northern Bushel (the Dipper) records people's deeds and lengthens or shortens their lives accordingly. The fear of hell is inculcated by life-sized, brilliantly painted figures in temples. The supreme triad consists of the recluse Lao-tzu, who has gone into retirement, the Jade Emperor, who now rules, and the future Savior.

Taoist practitioners today make their living chiefly by calling upon members of the divine hierarchy to defeat the machinations of the devils who cause diseases and calamities. They name the devil that has occasioned any trouble, and they know to which god to appeal for relief. Contemporary Taoism is a thoroughly superstitious and loosely organized

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*Ruins of the Greek Theatre on the promontory of Taormina, in northeastern Sicily, overlooking the Ionian Sea. Of Greek origin, the theatre in its present form dates from a Roman restoration of the second century A.D.*

system. Long decadent, it has lost the respect of intelligent Chinese. H. H. D.

**TAORMINA** [tɑ′ɔrmi′nɑ], a famous and historic resort town on the east coast of Sicily, midway between Messina and Catania. Situated on the side of the coastal range at an elevation of 650 ft., Taormina enjoys an incomparable view of the sea and of Mt. Etna. The combination of scenic beauty and mild climate has made of Taormina and its environs a well-known winter resort. There are numerous hotels as well as many private villas. Taormina was founded by Greek colonists at the end of the fifth century B.C. and shared the political history of the near-by Greek cities before and during Roman occupation. Its importance outlasted the Empire, but in 902 it was destroyed by the Arabs, who later rebuilt it. The city prospered under Norman rule but declined later. Among the monuments worthy of mention is the Greek theatre, constructed during the Hellenistic Period and second in size only to that at Siracusa among Greek theatres in Sicily. Taormina is the center for many excursions to beautiful and interesting sites, such as the Castle of Taormina and the Grottoes of Capo Sant' Andrea. Pop. 8,383.
R. G. W.

**TAOS.** *See* INDIAN TRIBES, NORTH AMERICAN (*Southwest*).

**TAPAJÓZ** [tapəzhɔ′s], a river which has its headwaters in the Brazilian state of Mato Grosso, about 95 mi. north of Cuiabá, the capital of that state. The Tapajóz flows northward for more than 1,000 mi. to enter the Amazon River at the town of Santarém. In its upper reaches, rapids and cataracts obstruct its course. Near its mouth, however, the river widens into a lake-like expansion about 10 mi. wide and over 70 mi. long. It is navigable for a distance of 175 mi. from its mouth, and regular steamship service is maintained. Belterra, the former Ford rubber plantation, is located 26 mi. south of the mouth of the Tapajóz, on the east bank.
P. E. J.

**TAPANULI** or **TAPANOELI** [tɑ′pɑnu′li], a residency on the northwest coast of Sumatra, in the province of North Sumatra in the Republic of Indonesia. Tapanuli residency includes Nias Island and covers a total area of 15,215 sq. mi. The capital of the residency is at Sibolga (pop. est., 10,765); other towns are Barus, Natal, and Padangsidimpoean. The residency is mountainous and includes Lake Toba in the northeast, the largest lake of Sumatra, regarded by the natives as holy. The territory in the interior around Lake Toba is known as Batakland, inhabited by the Bataks, a people at one time addicted to cannibalism, who are skilled artisans, shopkeepers, and farmers. Coffee, rubber, rice, tobacco, and maize, as well as fruits and vegetables, are cultivated, and stock raising is of importance. Tapanuli did not come under Dutch control until 1824. Nias Island, the largest island off the west coast of Sumatra, is almost entirely unaffected by western civilization. Pop. (est.), 1,043,000.
C. W. D.

**TAPARELLI, MASSIMO.** *See* AZEGLIO, MASSIMO TAPARELLI, MARCHESE D'.

**TAPESTRY,** a form of hand-woven decorative fabric. Its chief materials are colored wools. The great development of tapestry was in Gothic France, but the art may be traced to ancient cultures. Its changing styles afford valuable sources of reference to old customs, performing a documentary as well as a decorative function.

From the earliest times tapestry played a role in decorative and domestic usage. The ceremonies of the courts and the Church were often luxurious yet practical, and the flexibility of woven pictures meant easy storage and transportation. Records show that tapestry was used for royal occasions, temporary chambers, religious celebrations, and simply as draughtwalls in the cold stone halls of the medieval European castles and châteaux. When the nobility traveled they took with them tapestries, often of huge size and in sets which could be arranged as movable partitions to form a chamber.

The fortunes of war have resulted in sets of tapestries becoming widely scattered, and many of the greatest importance were cut in fragments. Centuries may pass before these sections are recombined. A third type of accident that lost us many splendid examples of the weaver's art was deliberate burning in order to recover the gold and silver in their threads.

The subject-matter of tapestries has been virtually limited to three great groups: religious, mythological, and royal illustration. Scenes from bourgeois life are comparatively few, and in general tapestries have depicted exalted or glorified legends or events. Biblical subjects prevailed in the Gothic period: the Queen of Sheba, the Presentation of Jesus, and Saint Remi. By the seventeenth and eighteenth centuries, taste for these subjects had diminished, and Louis XIV and Louis XV had elaborate secular tapestry-rooms constructed in the châteaux of Chambord and Compiègne. Popular with smaller households were *verdures,* designs in which an allover foliage green prevailed. Similarly there developed a love of all-over patterns, known as *mille-fleurs.* These latter give a presentiment of the kind of floral wallpaper which was to appear in home decoration and largely to replace costly woven pictures.

Closely associated with the subject and development of tapestry was the governmental support of state looms and factories. Chief designers established traditional subjects

and styles, and the technique particular to each weaver's city contributed to the manner in which tapestry progressed. Thus French designs were determined by the ateliers of Aubusson and Gobelins. England, imitating the success of Henry IV of France in importing low-warp weavers from Flanders in 1607, built a tapestry center at Mortlake, a suburb of London, in 1620. The success of the Aubusson and Gobelin looms was equaled by Mortlake in its set from Raphael's cartoons of *The Acts of the Apostles,* now in the French National Collection.

The Month of December, *one of a series of Gobelin tapestries woven in silk and wool, probably between the years 1732 and 1737, under the direction of Michel Audran, from a set of sixteenth-century Flemish cartoons known as* The Months of Lucas.

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*The Unicorn tapestries, remarkable for their design and beauty of coloring, are among the most extraordinary works of art of the sixteenth century. There are six tapestries and fragments of another in the Unicorn series, the five central pieces being made, in all probability, for Anne of Brittany in celebration of her marriage to Louis XII of France on January 8, 1499.*

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*THE SEIZURE OF CASSANDRA BY AGAMEMNON*

*This example of English Mortlake tapestry was completed during the seventeenth century. It is one of a set of eight hangings known as the* Royal Horses, *woven of silk and wool, after cartoons by Francis Clein.*

Tapestry identification has been made exceedingly problematical by the fact that, even in the Middle Ages and the Renaissance, sets of designs were repeatedly copied and plagiarized. However, poor reproductions or adaptations of old designs during the period of 1870-1940 makes it easy to judge tapestry quality, for then the weavers employed designers of the weakest and most derivative mannerisms; and the Gothic mythological quality was so sentimentalized as to make those tapestries definitely meretricious. The question of taste in tapestries is relatively complex, as in painting, but it will serve the speculator to consider if the woven-thread character of the material has been respected, and its essential flatness has not been tortured into illusionary depth. Most trained critics would immediately prefer those Gothic and early Renaissance tapestries which are clearly flat-textured designs to those technical triumphs of the Victorian weavers which ape so needlessly the devices of form and perspective associated with illusionary oil-painting.

Tapestries, especially from France, received a popular yet intelligent acclaim when, in 1946, a superb collection of ancient and contemporary tapestries was exhibited in Paris under the auspices of the Louvre. These outstanding examples from private and public collections were shown in Paris, Amsterdam, Brussels, London, New York, and Chicago, and for the first time an adequate view of this craft could be enjoyed and studied. Among the many shown were the incomparable fourteenth-century Apocalypse tapestries (the treasure of Angers), the series of the legend of St. Stephen from the Cluny Museum in Paris, and also from the Cluny Museum the six tapestries representing the lady with the unicorn. This exhibition again showed tapestry as a vital and stimulating art form, rescuing it from the despised power-loom imitations and the jejune facsimiles so long offered in auction rooms. Twentieth-century individualism in the arts affected tapestry design. Tapestries woven during World War II in France are characterized not so much by the loom (as Gobelin, Arras, or Beauvais) as by the style of the artist-designer himself. The weaving done at Aubusson in the 1940's brought a startling change to tapestry production. Woven after designs made by painters (Lurcat, Gromaire, Saint-Saëns, Dufy, Matisse, Guignebert, Marchand, Jean Picart Le Doux, and others), these tapestries surprised by their individualistic distortions and violence of creative originality. The ancient art of pictorial weaving was refreshed by the liberal and experimental devices and abstractions of the modern movement of the twentieth century. However, tapestry will continue its tradition of a craft halfway between functionalism and decorative enrichment.

**Techniques.** The techniques of tapestry weaving are comparatively simple. However involved and rich the tapestry, its designs are created by a rather elementary over-and-under weaving of colored wool threads on a cotton warp. (Carpet weaving is similar, but its threads are knotted and clipped to form the pile.) All tapestries are woven on looms arranged either vertically (*haute-lisse*) or horizontally (*basse-lisse*). The choice is determined by speed and cost. In each case the weaver rolls up the finished part on a drum roller and proceeds by a scrupulous study of the design or cartoon directly before him. The weaver (*tapissier*) himself almost never created the compositions, and was at one time legally forbidden to attempt to do so. Designs were largely the product of painters, and until the 1940's they were based upon conventionalized symbols and allegorical figures.

The weaver simply interweaves with a shuttle (or *flute* or *broche*) his wool strands, which closely match the tones of the cartoon. These tones were few in early tapestries, but rose to about 14,600 shades, until simplification in the 1940's reduced the colors to about 50 shades. Aniline dyes presented problems of fading, but light-fast hues of shrill intensity were frequently employed, and the laboratories of the Gobelins factory made careful research into the problem of color.

One of the technical trials of tapestry weaving is the low-loom problem of inspecting the "right" side of the result, by mirror reflections, beyond the warp threads. Another technical problem is the modeling of form to resemble three-dimensional mass. This must be done by crosshatching the stitches. With extreme detail, an effect of realistic oil painting, achieving even the contours of portraiture, can be contrived. This is fortunately no longer a desired dexterity, and even metal threads are rarely used.

The preservation and care of tapestries is akin to that of carpets and rugs. When not hanging, they should be rolled but not folded. When hung they require stiff webbing to which the rings are attached. Old tapestries must have linings, which should be well reinforced with diagonal stitching. Tapestries should not be hung as flat as a wall, but loosely; and to frame tapestries is to sacrifice their fabric quality. The washing, dusting, and repairing of tapestries is properly the work of museum experts. W. F. Ba.

**TAPEWORM,** a name given to cestode worms belonging to the genus *Taenia* and allied genera, parasitic in the adult stage in man and animals. The long, flat body is composed of a knoblike head, the scolex, and a great number of seg-

ments called proglottids. The head is furnished with suckers and frequently with hooks. Behind the scolex is a short neck followed by the proglottids which gradually increase in size from the anterior to the posterior end. There is no digestive tract; the dissolved food is absorbed through the body wall. Most of the tapeworms are hermaphroditic, each segment containing male and female organs. The life history is rather complicated, usually involving one or more intermediate hosts in which larvae mature. The most important tapeworms affecting man are the pork tapeworm, *T. solium,* and the beef tapeworm, *T. saginata.* A common fish tapeworm that infests man is *Diphyllobothrium latum.* Tapeworms are found parasitic in many other vertebrate animals.

R. F. N.

**TAPIOCA** [tæpio′kə], the starch extracted from the bitter cassava, *Manihot esculenta,* and the sweet cassava, *M. aipi.* It is obtained from the thickened rhizome, and is sold in coarsely granular form. When cooked, it swells, thickens, and becomes translucent. Tapioca, quite nutritious and easily digestible, forms an excellent diet for the sick and convalescent.

J. A. Bo.

**TAPIR** [te′pər], a clumsy-looking mammal of the genus *Tapirus* in northern South America; of the genus, or subgenus, *Tapirella* in Central America; and of *Acrocodia indica* in southeastern Asia and Sumatra. The tapir has an arched back, a very short tail, and a piglike head in which the muzzle is drawn out in a short, flexible trunk. The legs are short, and the toes, 4 on each front foot and 3 on the rear, are enclosed in separate, horny hoofs. American tapirs are entirely deep brown in color. The Asiatic species is distinguished by a broad white area on the body, while the fore parts and lower hindquarters are brownish black. Somewhat larger than the New World tapirs, the arched back of this species is 3 to 3½ ft. above the ground.

Tapirs inhabit dense, swampy forests, mostly along rivers, and feed on shrubs, herbs, and fruit. They swim, or wallow in mud to cool their thinly-haired skins. Being very shy, they are rarely seen. The flesh is not particularly appetizing, and tapirs are not often shot except for their hides. In Asia, their chief enemies are tigers, and in America they are preyed upon by jaguars and cougars.

V. H. C.

**TAPUYA.** *See* Indian Tribes, South American (*Principal Linguistic Families*).

**TARABULUS ESH SHAM.** *See* Tripoli.

**TARAHUMAR.** *See* Indian Tribes, North American (*Southwest*).

**TARAKAN** [tɑ′rɑkɑ′n], a small island off the northeast coast of Borneo, Republic of Indonesia, in the Celebes Sea. The island, with an area of approximately 118 sq. mi., is noted for its oil fields, which produce extremely high-grade oil, some of which requires little or no refining. Tarakan was taken by the Japanese in January of 1942, but the Dutch destroyed the oil wells and refining installations. Australian forces recaptured the island in May 1945. Pop. 11,600.

A. L. R.

**TARANCHI.** *See* Asiatic Tribes (*Ural-Altaic*).

**TARANTELLA** [tærəntɛ′lə], a very lively dance in 6/8 time, deriving its name either from the town of Taranto, in southern Italy, or from the tarantula which infests that region. Popular legend once held that the bite of this spider caused a disease known as tarantism which could be cured only by the frenzied dancing of the tarantella. Modern tests have shown the bite of this spider to be relatively harmless, but no doubt autosuggestion, coupled with the great physical exertion of the dance, played a part in allaying the hysterical fear caused by a bite. With its rapid, never-ceasing triplets, the tarantella is musically little different from the saltarello. Well-known examples in art music have been composed by Liszt, Chopin, Weber, and Daniel Auber, and the finale of Mendelssohn's "Italian" Symphony approaches the tarantella in style.

P. N.

**TARANTO** [tɑ′rɑnto], an Italian naval base, the capital of a province formerly of the same name but now known as Ionio, in Apulia, southeastern Italy, at the head of the Gulf of Taranto. The Greek colony of Taras, founded by settlers from Sparta on the site of the present city in the eighth century B.C., grew in power and wealth and at its height had a population of 300,000 living within a perimeter of 10 mi. After wars with the neighboring Lucanians, Messapians, and Bruttians, the Greeks had to face Rome on land and sea, sometimes in league with their late enemies as well as with Epirus and Carthage. The Romans finally subjugated Taras in 272 B.C., took huge quantities of booty, and renamed the city Tarentum. After the disintegration of the Roman Empire, there came a succession of alien invaders: Goths, Lombards, Byzantines, Arabs (who took the city three times and in 927 completely destroyed it), Normans, Hohenstaufens, Angevins, Aragonese, Spanish Hapsburgs, Bourbons, and the French under Napoleon. Few traces of the extensive Greek and Roman cities remain. The Romanesque cathedral, begun in the fourth century and rebuilt in the eleventh century, and the castle, of Byzantine origin and later enlarged by the Spaniards, are the two most interesting medieval remains. During World War I, Taranto was Italy's most important naval base and was much used by the Allied fleets. It became a provincial capital in 1923, which, in addition to its role as naval base, caused its rapid growth between World Wars I and II. On the night of Nov. 11-12, 1940, the British inflicted heavy damage on the vessels at anchor there and destroyed Italian naval superiority in the Mediterranean. Early in September 1943 the main body of the British Eighth Army landed at Taranto and pushed north across Apulia.

The city is built on two peninsulas, between which lies an island that once formed part of the southern peninsula but was separated from it by a canal dug in 1480 for reasons of defense. Now the two peninsulas and the island are connected by short bridges, under which flow the waters joining the gulf and the Mare Piccolo (Small Sea). The nearly landlocked Mare Piccolo is about 4 mi. long, and the Italian naval base is on its southern side, the eastern edge of Taranto. The outer bay, or Mare Grande, is almost circular,

*Castello San Angelo, a tenth-century fortification which guards the entrance to the Mare Grande, a bay of the Gulf of Taranto*

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enclosed by shoals and the islands of St. Peter and St. Paul, but having an entrance about a mile in width to accommodate large ships. Access to the Mare Piccolo and its installations is through the canal, past a swinging bridge. The modern city has expanded to the north and southeast of its medieval site on the island. Taranto is now a railroad center, a commercial port of importance, and the natural market for the agriculture of the surrounding region. There is extensive fishing, and oysters are dredged in the Mare Piccolo. The city has an institute of marine biology. A number of industries connected with shipping, foodstuffs, and the building trades have developed in Taranto since 1900. Pop. (off. est. 1947), 181,726. R. G. W.

**TARANTULA** [tərа′ntshulə], a hairy spider of the family Theraphosidae, the largest of the spiders. Theraphosids inhabit the warmer parts of the world; the name tarantula is applied particularly to those of the southern and

*TARANTULA, EURYPELMA EMILIA, A LARGE VENOMOUS SPIDER OF TROPICAL AMERICA*

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western United States. In Europe the name is given to a large wolf spider belonging to another family. Tarantulas usually live in holes in the ground or under rocks. They range in size from an inch to two inches or more in body length, and may reach a leg spread of eight or nine inches in some of the tropical "bird" spiders. They usually eat large insects, mostly beetles. They are nocturnal in their activities and are seldom seen, except when rain forces them from their burrows or when the males rove during the mating season. Though shy and furtive, tarantulas may inflict a painful bite when captured in the hand. Most of those occurring in the United States are not seriously poisonous, the bite seldom being worse than the sting of a wasp. Some tropical forms are capable of killing small animals. *See also* ARACHNIDA; SPIDER. W. I.

**TARAPACÁ** [tɑ′rɑpɑkɑ′], the northernmost province of Chile, bordered on the north by Peru (Tacna Department), on the east by Bolivia (La Paz, Oruro, Potozí departments), on the south by Antofagasta Province, and on the west by the Pacific Ocean. Tarapacá originally belonged to Peru but was ceded to Chile at the end of the War of the Pacific (1879-1884). The province has a total area of 21,346 sq. mi., largely composed of desert and narrow valleys. Two mountain ranges fringe the province: the Cordillera Occidental of the Andes on the east, and a lower coastal chain sloping into the shoreline on the west. The larger cities are the important coastal ports of Arica, Pisagua, and the capital, Iquique. Water and vegetation are scarce, and the major industry is the extraction of nitrate of soda from the province's rich mineral fields. Silver is also mined in the coastal range in the vicinity of Iquique, principal shipping point for this industrial area. Pop. (off. est. 1945), 99,724. S. G. I.

**TARAWA** [tərɑ′wə; tɑ′rɑwɑ′], a chain of long and extremely narrow coral islets, about 18 mi. long and 13 mi. wide at the widest point of the atoll, in the Gilbert Islands. It is located at 1° 30′ N. lat and 173° E. long., southwest of Hawaii in the central Pacific Ocean. Tarawa is the headquarters of the Resident Commissioner of the Gilbert and Ellice Islands Colony of Great Britain, of which it is a part. It was proclaimed a British protectorate at the request of the native governments in 1892, and annexed by Britain Nov. 10, 1915. Immediately after Pearl Harbor, Tarawa was taken by the Japanese and remained under their control until liberated by United States Marines Nov. 23, 1943. The defeat of the Japanese on Tarawa was accomplished only after bitter fighting and heavy casualties, marking the battle as one of the severest in the Pacific during World War II. The temperature ranges between 80° F. and 90° F. during the day and 70° F. at night. The islets are covered with tropical flora dominated by coconut palms. Pop. 1936, 2,640. R. G. B.

**TARAZONA** [tɑ′rɑthoˈnɑ], a city in Spain, located about 50 mi. northwest of the city of Zaragoza, in the western part of the province of Zaragoza, in Aragon. It is situated on a hill, surrounded by a plain through which flows the Queiles River, a tributary of the Ebro. Originally called Turiaso by the Romans, it was an old fortress town which played an important part in the Castillian-Aragon War of the fourteenth century. The city is the see of a Roman Catholic bishopric, and the cathedral dates back to the twelfth century. The Romanesque church of La Magdalena is an important tourist spot and the library of Tarazona is noted for its collection of historical literature. It is the center for the agricultural region of the surrounding plain, on which are raised grapes, cereals, and vegetables. The chief industries include the processing of wool, grapes, and lumber from the near-by hills. Pop. 1940, 11,237. L. M. A.

**TARBES** [tɑ′rb], capital of the department of Hautes-Pyrénées in southwestern France, located about 75 mi. southwest of Toulouse on the left bank of the Adour River, with views of the hills of Armagnac to the north and of the Pyrenees to the south. First known as Bigorra, seat of the counts of Bigorre, it was occupied by the English between 1360 and 1406. During the Wars of Religion (1569) it suffered at the hands of forces led by Count Gabriel de Montgomery, a general appointed by Jeanne d'Albret, Queen of Navarre, to establish Protestantism by force throughout her dominions. It suffered again when overrun by the forces of the Roman Catholic League in 1592. The twelfth-century cathedral, known as La Sède, built of brick, stone, and rolled pebbles, is in mixed styles, with a Romanesque apse and a Gothic cupola. The fifteenth-century cloister of a former Benedictine abbey, brought from neighboring St.-Sever-de-Rustan, stands in the Jardin Massey, which also contains a museum of paintings, sculpture, and antiquities. At Tarbes are an important arsenal and an artillery school. Among the industrial enterprises are forges, tanneries, pottery works, and electrical equipment, and chemical plants. Pop. 1954, 40,242. W. McE.

**TARBORO** [tɑ′rbʌrə], a town in eastern North Carolina, the county seat of Edgecombe Co., situated on the Tar River, about 65 mi. east of Raleigh. The town was founded and incorporated in 1760, and in 1950 it was governed by a mayor and council. The municipally-owned pasteurizing plants are a unique feature of the community, which has rail transportation supplied by the Atlantic Coast Line and

the East Carolina railroads. Tarboro is a marketing center for the tobacco, cotton, peanuts, beans, and corn grown in the district. The local plants manufacture cotton cloth, hosiery, cottonseed-oil and peanut products, and veneered panels. Pop. 1950, 8,120.

**TARDE, GABRIEL** [ta′rd] (1843-1904), French sociologist and lecturer in the *Collège libre des Sciences Sociales,* was born in Sarlat, in Dordogne, France, on Mar. 12, 1843. Educated at home and in Paris, for many years he taught in Sarlat, serving also as a local judge. His experience as magistrate led him to reject the prevailing theories of a biological basis for criminality and to seek causes of crime in social behavior. In the 1880's he moved to Paris, aided in founding the *Archives d'anthropologie criminelle* in 1886 and later became its editor. As a result of his studies and writings he acquired an international reputation as a criminologist. He published *La Criminalité comparée* (1886) and *La philosophie penale* (1890). As chief of the Bureau of Statistics of the Ministry of Justice, to which position he was appointed in 1894, he made extensive studies of criminality. Several years after this appointment his interests broadened and he developed a system of sociology based on imitation. Toward the end of his life, 1899-1904, he was professor of modern philosophy at the Collège de France.

His sociological theory as outlined in *Les Lois de l'imitation* (1890) and *Les Lois sociales* (1898) is built on the thesis that the fundamental social act is imitation of one person by another. His ideas of imitation, however, are quite complex and include adaptation, or invention, and even opposition as special forms of imitation, in addition to the more familiar notion of repetition of observed actions. Imitation, he taught, proceeds in a wavelike fashion and these waves may either reinforce or diminish each other. Thus an invention is the fortunate coincidence and reinforcement of waves put into motion by creative persons. His philosophy was essentially individualistic and was attacked with vigor by the more group-minded Émile Durkheim, with the result that French sociology was split into opposed schools. He died in Paris, May 15, 1904. H. E. M.

**TARDENOISIAN** [tɑrdənɔi′ziən], a European culture of Mesolithic type, after Fère-en-Tardenois, Aisne, France, and characterized by microlithic flints, often of geometric forms, found in France, the Netherlands, Britain, Germany, Poland, and south Russia, commonly on open sandy sites or on exposed uplands, but also in caves and in coastal middens as at Téviec. In France the Tardenoisian culture is younger than the Azilian and overlaps in time with Neolithic cultures in the same country. The Tardenoisians continued to maintain a Mesolithic mode of life on the poorer soils, while the earliest farmers were establishing themselves on more fertile lands. J. G. D. C.

**TARDIEU, ANDRÉ PIERRE GABRIEL AMÉDÉE** [ta′rdyœ′] (1876-1945), French statesman, was born in Paris Sept. 22, 1876. He was admitted to the École Normale Supérieure in 1895, but caused a sensation by leaving the school immediately. He became a journalist, specializing in foreign policy problems, taught at Harvard University in 1908, at the École des Sciences Politiques in 1909, and was appointed professor of political science at the École Supérieure de Guerre in 1911. A member of the Chamber of Deputies from 1914 to 1924, he nevertheless fought in World War I as a reserve officer, was three times wounded and three times cited for bravery. He was sent to the United States with the Joffre mission in 1917. Shortly afterwards, he became closely associated with Georges Clemenceau, and was his chief adviser in the negotiations that led to the Treaty of Versailles. He thus played a particularly important part in the drafting of the political and territorial clauses of that treaty. He was minister of liberated regions, 1919-1920, minister of public works, 1926-1928, minister of the interior, 1928, premier, 1929-1930, minister of agriculture in 1931, and premier again in 1932. Throughout this period he stood for the type of strong policy which had been represented by Clemenceau, and he fought vigorously against all attempts to revise the Versailles Treaty. From 1933 on, he became outspoken in his criticism of the current French régime, although, after the riots of February 1934, he served as minister without portfolio in the conciliation cabinet headed by Gaston Doumergue (February-November 1934). In 1936 he refused to take part in the electoral campaign, and subsequently bitterly attacked the parliamentary system as then practiced in France. Early in 1939, shortly before World War II, Tardieu's health broke down and he retired to Menton, a town on the French Riviera. There he died on Sept. 15, 1945. G. E. L.

**TARENTUM** [tərɛ′ntəm], a borough in Allegheny Co., in southwestern Pennsylvania, situated on the Allegheny River, 21 mi. northeast of Pittsburgh. Founded in 1796 by Felix Negley, who built a grist mill at the mouth of Bull Creek, the community was named after the ancient Roman seaport; it was incorporated as a borough in 1842. Community affairs are administered by a burgess and council. Transportation facilities are provided by the Pennsylvania Railroad. The first petroleum used commercially in the United States was produced in Tarentum. Thomas and Samuel Kier in 1847 leased a piece of land near Tarentum on which to drill for salt, and, while drilling, discovered oil, which they bottled and marketed as "Petroleum or Rock Oil," medicine for many ills. Samuel attempted to distill petroleum, and in 1855 he built his first successful still. He sold the oil for illuminating purposes and perfected an oil-burning lamp. During a visit to Pittsburgh in 1857 Colonel A. C. Ferris of New York saw the Tarentum oil burning in a lamp, and he arranged with Kier to market it in New York. In 1858 the production of crude oil in Tarentum amounted to approximately 1,000 barrels, at a price averaging $30 a barrel. Besides petroleum, there are natural resources of gas, bituminous coal, sand, and gravel in the district, and these are the basis of the borough's development as a leading steel, glass, chemical, and bronze manufacturing community. Coal mining is one of the most important industries in the locality. Pop. 1950, 9,540.

**TARGET SHOOTING,** a competitive or individual sport in which rifles or pistols are fired for accuracy at a fixed objective. The sport is as old as firearms and is practiced throughout the world.

In America, turkey shoots at festive gatherings and Kentucky long-rifle matches were early counterparts of modern target shooting. Target shooting as a national sport had its beginning in 1871 when a group of state militia officers and Civil War veterans organized the National Rifle Association at Creedmor, Long Island, N. Y. This association expanded steadily and is now the parent organization of well over 4,000 units, with more than 250,000 individual members. In 1902 the National Matches were established by an Act of Congress. These National Matches are rifle and pistol target-shooting competitions conducted annually in September at

Camp Perry, Ohio, under the supervision of the United States Army.

**Types of Modern Matches.** Practically all modern competitive matches are standardized under rules and specifications of the National Rifle Association, which has also played an important role in the development of the National Matches. This organization conducts its own championships at the Camp Perry Nationals each year and pays the expenses to the matches of winners in regional competitions. It awards cash prizes and trophies at the Nationals.

Target-shooting matches take many forms. Some are for specific personnel only, such as service, police, or civilians, while others are open to all who wish to compete. The shooters are grouped into various classifications: master, expert, sharpshooter, marksman, and tyro—depending upon their previous records at official matches. Matches are conducted at various ranges. Service and other .30-cal. rifles are shot over 200- and 500-yd. ranges. Small-bore competitors, a group making up the majority of rifle target shooters, generally fire over 50- and 100-yd. ranges. Indoor matches, such as those conducted for collegiate and scholastic competition in the spring of the year, are shot on 50-ft. ranges.

In rifle target shooting, each competitor fires from four positions: prone, sitting, kneeling and offhand, or standing. He is judged on his aggregate score from these four positions.

Pistol target matches are conducted for .45-cal., .38-cal. and .22-cal. hand guns. In a typical match, each shooter fires ten slow-fire shots at 50 yd., ten timed-fire at 25 yd., and ten rapid-fire at 25 yd. He is judged on his aggregate score.

**Equipment.** The type of cartridge, such as the .22-cal. long-rifle match ammunition used by small-bore target shooters, is strictly defined by match regulations. Also, the type of sights which may be used in various matches is specified. Matches are divided into two groups: one in which metallic sights only are allowed, and the other in which any type of sight is permitted. The first classification eliminates optical sights. In the open matches where any sights are permitted, however, optical telescope sights of from 8 to 24 power are commonly employed.

Rifles are open to considerable variation according to individual tastes and requirements. The modern target rifle is generally much heavier than a corresponding hunting rifle. In the .22-cal. category, for instance, a hunting rifle will weigh from 5 to 7½ lb., while the target rifle may weigh from 11 to 17 lb. This added weight produces less barrel vibration and makes it possible for the shooter to hold the rifle steadier; however, a gun of this weight is impractical to carry in the field. D. Ho.

**TARGUM** [tɑ′rgʌm; tɑrgu′m] (pl. Targumim), the Hebrew and Aramaic word for translation. Specifically, the term is applied to Aramaic translations of the Bible. When Hebrew was replaced by Aramaic as the spoken language of the Jews (probably shortly before the beginning of the Christian Era), the need for targumim arose. In synagogues of the early centuries of the Christian Era, a person was employed for the specific purpose of translating scripture into the vernacular as it was read. In time, targumim were written down.

The most important of extant targumim is the *Targum Onkelos* of the Pentateuch. The name *Onkelos* is a distorted form of *Aquila;* it is possible that it means "a faithful rendering," "in the manner of Aquila," but it is more probable that it was used through confusion with a reference to Aquila's Greek translation of the Bible. This targum is also called the Babylonian Targum, being referred to in the Babylonian Talmud as "our targum." Linguistic evidence suggests that it may have been begun in Palestine, but it was completed in Babylonia, reaching its final form at about the end of the fifth century. It is regarded as authoritative and is commonly printed alongside the Hebrew text in Hebrew Bibles. It is a rather faithful translation, but it generally avoids anthropomorphisms and in many cases employs euphemisms. Other extant targumim of the Pentateuch are the fragmentary Jerusalem Targum and the Pseudo-Jonathan, Targum, the latter so called from having been wrongly attributed to Jonathan ben Uziel. These, incorporating much Haggadic and exegetical matter are far less literal than the Onkelos.

In addition, there are the Targum Jonathan to the prophetic books of the Bible and individual targumim to all the books of the Hagiographa except Daniel, Ezra, and Nehemiah, for which no targumim have been discovered. The general character of these targumim is interpretive and exegetical rather than literal. D. G.

**TÂRGU-MUREŞ** [tɪ′rgumu′reʃ] (Hung. Maros-Vásárhely), a city in Transylvania, north central Romania, on the Mureşul River about 165 mi. northwest of Bucharest. It was once the capital of the territory of the Szeklers, and an old citadel on a hill overlooking the city contains a beautiful church in Gothic style built about 1446. The city's trade is chiefly in timber, petroleum, grain, wine, tobacco, and fruit. Its most important industries are distilling and the refining of sugar beets. Pop. (off. est. 1948), 47,043. S. A.

**TARIFF.** *See* Trade and Exchange (*Trade Volume*).

**TARIM DARYA** [dɑ′ri′m daryɑ′], a river about 1,250 mi. long, one of the larger rivers in south central Asia. The Tarim rises in the high Karakoram Range near the Karakoram Pass between Kashmir, India, and Sinkiang Province of China. The river flows generally northward across the mountains and in the Tarim Basin bends to the northeast and east. It then decreases in size as it flows across the dry Tarim Basin and eventually disappears in a series of small swamps and lakes west of Lop Nor. The river, with its major tributaries—the Khotan Darya, the Kashgar Darya, and the Yarkand Darya—forms the most important source of water and is a transportation route across Sinkiang and the northern edge of the Takla Makan Desert. The chief city on the Tarim is Soche (Yarkand), but there are numerous small settlements along its banks, where the combination of alluvial soil and water makes agriculture possible. The Tarim Basin comprises an area of about 350,000 sq. mi. J. E. F.

**TARKINGTON, (NEWTON) BOOTH** (1869-1946), American novelist, was born July 29, 1869, in Indianapolis, Ind. He attended Phillips Exeter, Purdue, and Princeton, where his artistic versatility was demonstrated by college success in music, drawing, and writing. This ability he soon applied more specifically to literature as a profession. His first novel, *The Gentleman from Indiana* (1899), concerning a country editor's crusade against corrupt politics, is one of his best; but it was the second, *Monsieur Beaucaire* (1900), a pseudo-historical romance, that secured his reputation. Of some thirty other novels, the outstanding are *The Conquest of Canaan* (1905); *Penrod* (1914), *Penrod and Sam* (1916), and *Seventeen* (1916), all humorous pictures of the American adolescent; and *The Magnificent Ambersons* (1918) and *Alice Adams* (1921), studies of social and economic forces, both of which won Pulitzer Prizes. Tarkington was gener-

ally faithful to Middle Western actuality, but his realism is sentimental and given to flattering the popular faith in the eventual triumph of virtue. His plots are commonly subordinated to the analysis of character.

Tarkington tried other genres, but without notable success. *In the Arena* (1905) is a collection of stories about political life; *Looking Forward* (1926), a book of essays; and *The World Does Move* (1928), a volume of reminiscences. *Tweedles* (1923), written in collaboration with Harry Leon Wilson, is the best known of his plays. In 1930

BOOTH TARKINGTON

BROWN BROTHERS

Tarkington lost his sight, which was later partially restored. He spent his winters in Indianapolis and his summers in Kennebunkport, Maine, where his beached schooner, the *Regina,* served as a workshop. He died May 19, 1946, in Indianapolis. W. P. R.

**TARLAC** [tɑ′rlɑk], the name of both a province and its capital, located in the central part of Luzon, in the northern part of the Republic of the Philippines. The province is bordered on the north by Pangasinan Province, on the east by Nueva Ecija, on the south by Pampanga, and on the west by Zambales. The eastern slopes of the Zambales Mountains form the western part of the province, where corn and tobacco are the chief crops, while the central and eastern section is a fertile plains region, producing rice, sugar, vegetables, and pineapples. Under Spanish rule Tarlac was originally included in Pampanga province. Part of it became a military command in 1860; the whole area joined the revolt against Spain in 1896. Civil government was established by the United States in 1901. During World War II the province was occupied by the Japanese in December 1941 and liberated by American forces in January 1945. Pop. 1948, 327,018.

The town of Tarlac, administrative center of the 42 barrios or districts in the province, is situated on a level plain about 65 mi. northwest of Manila, on a tributary of the Agno River and on the Manila-Dagupan Railroad. Founded in 1686, Tarlac is the chief trade center of the region. Its industries are the processing of rice and sugar cane, lumbering, and the manufacture of pottery and wooden shoes. Tarlac is a municipality consisting of three barrios: San Roque, in the south, a residential and administrative area; and, in the north, Matatalaib, the business district, and San Nicolas, an industrial and residential district. Principal buildings are the provincial capitol, the municipal building, and the Manuel Roxas Memorial Library. The hospital, built in 1924, was the first provincial hospital in the Philippines. The town was partially destroyed by the Japanese in World War II. Pop. 1948, 64,597.

**TARN** [tɑ′rn], a department in southern France, with an area of 2,231 sq. mi., bounded by the departments of Aveyron on the northeast, Hérault on the southeast, Aude on the south, Haute-Garonne on the southwest, and Tarn-et-Garonne on the northwest. The climate generally is mild, with long summers and short winters. Tarn is crossed by offshoots of the Cévennes Mountains in the southeast, plains in the southwest, and a plateau in the north which is part of the Plateau Central. The Aveyron, Tarn, and Agout are the chief rivers. Cereals, fruits, vegetables, and mulberry trees and chestnuts from the environs of Lavaur are the chief agricultural products. There is excellent pasturage in the southern valleys of the Agout and its tributaries, where horses are bred for the cavalry and mules for shipment to Spain; cattle and sheep also are bred, and hogs are fattened. Mazamet, center of the textile industry, is foremost in Europe for shearing wool from sheep hides imported from Australia and America. More than 30,000 tons are treated here annually. Woolens are manufactured at Albi, Lavaur, and Réalmont; cheaper textiles at Vabre and Brassac; and clothing at Castres. There is an extensive furniture industry, specializing in children's furniture, at Albi, Rabastens, and Castres. At Albi, the prefecture, on the left bank of the Tarn, is the Gothic cathedral of Ste. Cécile (1282). At Cordes, founded in 1222, there are buildings dating from the fourteenth century. Tarn exports sparkling wines from Gaillac, morocco leather products, and woolen and nappy fabrics. Tarn was formed in 1790 from part of the old province of Languedoc. Pop. 1954, 308,197.

**TARN-ET-GARONNE** [tarne′gɑ′rɔ′n], a department in southwestern France, with an area of 1,440 sq. mi. The department is bounded by the departments of Lot on the north, Aveyron on the east, Tarn and Haute-Garonne on the southeast, Gers on the southwest, and Lot-et-Garonne on the northwest. The climate is mild. There is a plain bounded by the Tarn, Garonne, and Aveyron rivers, and there are hills in the northeast. Agricultural products include maize, wheat, rye, barley, flax, hemp, mulberry trees, plums, and apricots. Sheep, mules, horses, and cattle are bred. The department is noted for brandy and cavalry horses. Freestone is produced at Bruniquel, St. Antonin, and Caussade; tanning chemicals at Bruniquel; silk and lingerie at Montauban and Bruniquel; cheese at Montauban and Valence-d'Agen; wax candles and furniture at Montauban; and hats from imported Oriental straw at Caussade, Montauban, and Septfonds. The principal exports are fruit, truffles, vegetables, and wine. Montauban, the prefecture, has a fourteenth-century brick church; at Moissac is the Church of St. Pierre (1063); and at St. Antonin is a restored twelfth-century Hôtel de Ville. Tarn-et-Garonne was formed in 1808 from the old provinces of Guyenne, Gascogne, and part of Languedoc. Pop. 1954, 172,379. S. Van V.

**TARO** [tɑ′ro], an herb, *Colocasia esculenta,* also called dasheen or elephant's-ear, from the huge, bright green leaves which are often 3 ft. long and nearly as wide. This herb is of the arum family, widely grown in the tropics for the tubers, which are used as food, and elsewhere for ornamental purposes. It is a native of Fiji and Hawaii, where the starchy

root is fermented and made into a food called *poi*. In Japan, taro tubers are eaten like potatoes, and the young shoots and leaves are used as a vegetable. The Egyptian taro, *C. antiquorum*, cultivated from ancient times, is a native of India, but is inferior as a food to the Pacific taro. J. C. Wis.

**TARPON** [tɑ′rpɒn], *Tarpon atlanticus*, a silvery, large-scaled fish of the family Elopidae. Also called silverfish, it resembles a large herring. It has a bony gular plate between the lower jaws and a prolongation of the last dorsal fin rays. It is widely found in the Atlantic from Brazil and the west coast of Africa northwest to Long Island, and is especially common in coastal areas in the Caribbean region where it often enters the rivers. It is also found in Lake Nicaragua.

COURTESY OF THE U. S. FISH AND WILDLIFE SERVICE

*Tarpon, Tarpon atlanticus, a marine fish common to the coastal waters of Florida, the Gulf of Mexico, and the Caribbean area*

Swimming with great speed, the streamlined body is propelled by a powerful forked tail. The tarpon feeds on fishes. It often leaps clear of the water to a vertical height of 10 ft., and horizontal leaps of 20 ft. are on record. As a big game fish, it has a well-deserved world-wide reputation. A record specimen caught on rod and reel in Mexico weighed 247 lb. and was about 7.5 ft. long. A still larger one, more than 8 ft. long and over 350 lb., was netted in Florida waters. Little use is made of the flesh, but the large attractive scales are used in making ornaments. A smaller related species, the oxeye, *Megalops cyprinoides*, occurs in the Indian and Pacific Oceans. E. C. R.

**TARQUINIA** [tɑrkwi′nyɑ], a town in the province of Viterbo, central Italy, about 45 mi. northwest of Rome. The town is located on a hill at an altitude of almost 500 ft. along the left bank of the Marta River, not far from its mouth on the Tyrrhenian Sea. Tarquinia was an important Etruscan and Roman center. Its origins were in the tenth century B.C., coinciding with the development of the Iron Age civilization in Italy. During the following three or four centuries, Tarquinia became the capital of a powerful state, part of the great Etruscan confederation, extending from the sea to Lake Bolsena. According to tradition, the royal dynasty of the Tarquinii fought against the rising power of Rome in a number of long and bitter wars about the middle of the fourth century B.C. Finally, Tarquinia entered into Rome's political sphere of influence as a federated state. Later, it became a free municipium, achieved great importance in the latter part of the first century of the Christian Era, and became the seat of a bishopric. After a period of decadence, the town was deserted by the remaining inhabitants, who moved to a near-by hill, the medieval fortified town of Corneto (which in recent times has taken the name of Tarquinia). During the Middle Ages, Corneto played a fairly important role in the struggles between the emperors and the popes, siding with the latter. In the fifteenth century, the town was ruled by the Vitelleschi family and later became part of the popes' domain.

Excavations conducted since about 1900 have led to the discovery of remains of the Etruscan city. Especially important is the necropolis, with subterranean chambers richly decorated, many of their paintings remarkably preserved. These paintings—of banquets, games, religious ceremonies, the funeral of the deceased, and the trip to the other world in the Etruscan conception of it—offer the best available documents of the development of Etruscan art and civilization between the sixth and the second century B.C.

The medieval imprint is still evident in the high walls, narrow streets, and many towers. There are remnants of the castle of Countess Matilda of Canossa; even better preserved are the Church of Santa Maria in Castello, built in the early twelfth century by Lombard architects, and the Palazzo Vitelleschi, erected in 1439 by Cardinal Giovanni Vitelleschi. Pop. (off. est. 1947), 9,776. L. J. W.

**TARQUINIUS** [tɑrkwɪ′niəs], the name of two legendary kings of Rome.

**Lucius Tarquinius Priscus.** Lucius Tarquinius Priscus, fifth legendary king of Rome (616-578 B.C.), was probably of Greek origin. He married a Tuscan lady of rank and influence and settled in Etruria, later moving to Rome, where he was admitted to Roman citizenship. He became the confidant of Ancus Marcius, King of Rome, and was elected his successor. He fought the Sabines and conquered Latium. During his reign many public works were erected, including the Roman cloacae and the Circus Maximus, where the great Roman games were held. He is credited with initiating the Roman triumphal parade, which he led dressed in a robe of purple and gold, seated in a chariot drawn by four horses. He instituted political changes in Rome, particularly in increasing the number of senators to thirty and doubling the number of knights. He is said to have begun the capitol in order to honor Jupiter, Juno, and Minerva. He was assassinated at the instigation of the sons of Ancus Marcius.

**Lucius Tarquinius Superbus.** Lucius Tarquinius Superbus, seventh and last of the legendary kings of Rome, (534-510 B.C.) and son of Lucius Tarquinius Priscus, was too young to succeed his father. He coveted the throne and spent much of his youth intriguing against his brother-in-law, the king Servius Tullius. At length, he excited the patricians against the king, procured his murder, and himself ascended the throne. He abolished much of the progressive legislation enacted by Servius Tullius and attempted to set up a pure despotism, but finally he was forced to flee Rome with his family because of the outrage of his son Tarquinius Sextus upon Lucretia. He died in exile at Cumae. Since much overlapping and contradiction occur in the legends dealing with the Tarquinii, it is difficult to separate truth from fiction and to determine which acts should be attributed to which king. T. R. H.

**TARRAGON** [tæ′rəgən], a bitter, aromatic perennial herb, *Artemisia dracunculus*, of the family Compositae, allied to wormwood and sagebrush. It is a native of Europe and Asia and is cultivated especially in parts of France, where the leaves are dried and used commercially to flavor tarragon vinegar and to produce oil of tarragon. It grows to about 2 ft. in height. E. R. C.

**TARRAGONA** [tɑ′rrɑgo′nɑ], the name of a province and its capital city in Catalonia, northeastern Spain.

**The City.** The city of Tarragona is a seaport on the Mediterranean Sea, about 55 mi. southwest of Barcelona. The

site was occupied in the sixth century B.C. by an Iberian people who built cyclopean walls and left many ceramic objects. Taken from the Carthaginians under Hanno by Scipio in 218 B.C., during the Second Punic War, and given the name of Tarraco, the city was highly fortified. Augustus made it the capital of the largest of the three Hispanic provinces, Hispania Tarraconensis. The Visigoths arrived in 475 under Euric and inflicted much damage. The Arabs repeated the process in 713, and their rule lasted to 1119, although the Count of Barcelona held the city temporarily in 1089. A Norman adventurer held it as a border fortress against the Arabs, and in time the local archbishop came to exercise wide political powers and to be accepted as coprimate of Spain. During the War of the Spanish Succession, Tarragona was captured by the British in 1705. It capitulated to the French in 1811 after a seven-week siege. It was among the last cities to be captured by the rebels in the Civil War of 1936 to 1939. The Archbishop of Tarragona was one of few prelates to oppose Francisco Franco's revolt against the Republic.

*THE SEMINARIO CONCILIAR OR PRIESTS' SEMINARY, BUILT ON THE TERRACED HILLSIDE AT TARRAGONA, SPAIN, WAS DECLARED A PONTIFICAL UNIVERSITY BY POPE LEO XIII IN THE LATE NINETEENTH CENTURY.*

EWING GALLOWAY

Among the Roman relics are the Aqueduct of Las Ferraras, with two levels of arches and a length of 720 ft., restored to use between 1781 and 1800; the Forum, recently excavated; a so-called Palace of Augustus; an amphitheatre; and a Roman-Christian necropolis.

In 1903 a group of monks of the Grande Chartreuse began producing their liqueur at Tarragona. The city is famous for its wines, which are exported in substantial quantities, along with fruit and other agricultural produce of the region. Manufactures include textiles (silk, cotton, and linen), alcoholic beverages, and paper. Pop. 1950, 36,807.

**The Province.** The province of Tarragona has an area of 2,426 sq. mi., much of which is mountainous, rising to elevations in excess of 4,500 ft. The rocky coast line is fairly even and has few inlets. Only in the south is it broken by the wide and marshy delta of the Ebro River. The climate is mild and rainfall averages 18 in. annually, though little falls in summer and irrigation is necessary. Only the Ebro flows the year round. Agriculture is the leading activity; cereals, wines, fruits, vegetables, and olive oil are the chief products. Textiles, leather goods, soap, paper, and processed food are manufactured. Though minerals are known to exist, they are not extensively exploited. Leading cities in the province, besides the capital, are Tortosa, Reus, and Valls. Pop. 1950, 356,864.

R. G. W.

**TARRANT CITY** [tæ′rənt], a city in Jefferson Co., in north central Alabama, about 5 mi. north of Birmingham. It is an industrial community with activities centered in coal, coke, cast-iron pipe, and Portland cement. It was incorporated as a town in 1918 and as a city in 1927. Tarrant City is governed by a mayor and council. It is served by the Louisville & Nashville Railroad. Pop. 1950, 7,571.

**TARRYTOWN,** a village in Westchester Co., in southeast New York State. It occupies high ground on the east bank of Tappan Zee, a lakelike portion of the Hudson River, in the famous Sleepy Hollow district, 24 mi. north of New York City. It is a residential community and was incorporated as a village in 1870. It is governed by a mayor and council. Tarrytown was settled by the Dutch in 1645. At the north end of the village is the André Monument near the spot where the British spy, Major John André, was captured in September 1780 en route to meet Benedict Arnold. Other historic points of interest in Tarrytown and adjoining North Tarrytown and Irvington include Washington Irving's home, Sunnyside; the former home of Jay Gould, Lyndhurst; the Old Dutch Barn with a collection of early Dutch archaeological material; Castle Philipse, built by Frederick Philipse in 1683 and now a museum; and the Old Dutch Church with the Sleepy Hollow Cemetery, in which are the graves of Washington Irving, Carl Schurz, and Robert G. Ingersoll. Tarrytown is the seat of Marymount College for women and many private schools. It is also a summer resort. Transportation is provided by the New York Central Railroad, river craft, and, in summer, a ferry to Nyack pending completion of the bridge across the Tappan Zee forming a link of the New York State Thruway. Local manufactures include automobiles and garments. Pop. 1950, 8,851.

**TARSIER** [tɑ′rsiər], a small, nocturnal, tree-living primate, sole living representative of the suborder Tarsioidea. The tarsier, *Tarsius spectrum* and related forms, is found in Sumatra, Borneo, Celebes, the southern Philippines, and in a few smaller islands. It is the size of a small squirrel, having a body about 6 in. long, and 10-in., slender, tufted tail. The hind feet are elongated, especially the ankle bones. The eyes are unusually large, the muzzle is fine and short, and the ears are broad. The fur is dense and woolly, and of a brownish, grayish color below; there is a dark rising around

IFOR THOMAS

*THE EAST INDIAN TARSIER*

the eye. The tarsier feeds on insects and other small animals. It leaps, froglike, from bough to bough, clinging to smooth branches by its large finger- and toe-pads. *See also* PRIMATES.
J. E. Hi.

**TARSUS** [tɑ′rsəs], a famous historical city in south central Turkey, in the vilayet of Içel, a few miles inland from the Mediterranean Sea and 25 mi. southwest of Adana. The Cilician Gates, a famous pass through the Toros Dağlari (Taurus Mountains) are 50 mi. north of the city. Tarsus' strategic location on a fertile plain near the pass and on the now nonexistent Cydnus River (giving it access to the sea and making it a port) aided its development but also made it a prize for invading armies. The founding of the city has been attributed to Sardanapalus, to the god Sandan, to Perseus, and to Hercules. Its first historical mention is its capture by the Assyrians. During the Persian period it flourished. During the Greek period it was the seat of a school of philosophy. When the Romans conquered the region in the first century B.C., Tarsus became the chief city of Cilicia. Augustus made it a free city and the seat of one of the three great universities of the pagan world. When it finally came under Ottoman control in the late fourteenth century, Tarsus had paid allegiance to the Byzantines, Crusaders, and every major power in the East. It is noted as the birthplace of St. Paul. Although much of the ancient city is buried beneath alluvial soil from the Cydnus, excavations have discovered artifacts dating back as far as the Stone Age. Pop. 1950, 33,822.
J. E. F.

**TARTAR.** *See* ASIATIC TRIBES (*Ural-Altaic*).

**TARTARUS** [tɑ′rtərəs], in Greek mythology, a place of punishment in the underworld. After their defeat the Titans were imprisoned in Tartarus, and there, too, were the traditional sinners Ixion, Tantalus, Sisyphus, and Tityus. *See also* UNDERWORLD.
G. E. D.

**TARTINI, GIUSEPPE** [tɑrti′ni] (1692-1770), Italian violinist, composer, and teacher, was born at Pirano, Istria, April 8, 1692. After an adventurous youth, Tartini established in Padua in 1728 a school of violin playing whose fame soon spread throughout Europe. In his school, Tartini inaugurated the use of thicker violin strings and used a bow made of lighter wood, with a less marked convex curvature. He also made studies in acoustics and the theory of music. Tartini's literary works on music are almost as numerous as his 350 musical compositions; his violin sonatas, especially the *Devil's Trill,* are frequently performed today. Tartini died at Padua, Feb. 26, 1770.
P. G. G.

**TARTU** [tɑ′rtu], formerly called by the German name Dorpat, and earlier by the Russian name Yurev, a town located in the eastern Estonian S.S.R., at 58° 25′ N. lat. and 2° 45′ E. long. It lies on both banks of the short Ema River, draining the small Lake Virts eastward into Lake Peipus (Chudskoe Ozero). Founded in 1030 by the Kiev Grand Prince Yuri or Yaroslav, it is one of the most ancient towns in the Baltic region. An Estonian castle built on the site was taken by the Teutonic Knights in 1224. In the fourteenth century it joined the Hanseatic League and achieved considerable prosperity in commerce. Taken by the Russians in 1558, it passed to Poland in 1582, to Sweden in 1600, again to Poland in 1603, and back to Sweden in 1625. During the siege of 1625 the town was partly burned. Besieged by the Russians in 1666 and 1704, it was again burned in 1708, and many inhabitants were exiled. As a result of another great conflagration in 1777, the town was rebuilt in a more modern style. Fighting in the struggle against the Bolsheviks from 1918 to 1920 brought further damage to the town. In 1920 Tartu was included in the new republic of Estonia, but it passed under Soviet control in 1940 when the country became a Soviet republic within the Soviet Union. Occupied by Nazi forces in 1941, it was liberated by Russian troops in 1944. During World War II it suffered heavy destruction, and most of the noteworthy structures received considerable damage. The Ratshof contains one of the finest picture galleries in the Baltic area. However, the chief attraction of Tartu is the university, founded in 1632 by Gustavus Adolphus and twice suppressed, but reopened in 1802. It has been a center successively of Teutonic, Russian, and Estonian culture. Tartu, the principal city of interior Estonia, has a small river port and a large timber and pulp industry. Pop. (est. 1950), 60,000.
C. C. H.

**TARTUFFE** [tɑ′rtü′f], a French five-act comedy in verse by Molière (Jean Baptiste Poquelin, 1622-1673). It was originally a three-act play, and as such was first produced at the court of Versailles in 1664. On account of its antireligious implications it was immediately forbidden. The ban was lifted by Louis XIV on Feb. 5, 1669, in a prevailing atmosphere of tolerance. Tartuffe is a religious hypocrite who speaks the language of the devout even while pursuing the most sinful and most criminal aims. The virtuous but naïve Orgon is easily taken in, and his infatuation with the impostor brings him and his family to the verge of disgrace and ruin. Molière disclaimed any intention to offend religion. Actually, he aimed at discrediting some devout people associated with the Compagnie du Saint Sacrement, who opposed the theatre in general, and Molière in particular. He was directly inspired by what he saw around him, although he borrowed from Boccaccio, Regnier, and Scarron's *L'Hypocrite,* 1662. *Tartuffe* is one of Molière's most completely realized studies of character.
H. L. B.

**TARWEED,** a name given to various species of *Madia,* heavy-scented, viscid herbs of the family Compositae growing in western America. The common tarweed of California is a variety of *M. sativa,* and is a useful forage plant for sheep pastures in dry warm soil. The showy tarweed, *M. elegans,* of California gardens, is a graceful annual, 1 to 4 ft. high, bearing yellow daisylike flowers throughout the summer.

The name is also given to *Hemizonia corymbosa,* the coast tarweed. J. C. Wis.

**TASHKENT** [tɑ′shkɛ′nt], the name of a region and its capital city in the Uzbek S.S.R. in the central southwest Soviet Union.

**The City.** Tashkent lies in a great oasis on the Chirchik River, 42 mi. above its confluence with the Syr Darya at the western end of the Kirghiz Range, about 170 mi. north of Stalinabad. Though believed to be an ancient city, Tashkent was not referred to until the seventh century. For centuries it was a focus of caravan routes and a center of trade in central Asia. Russia took the city in 1865, when the entire territory of Turkestan was added to the empire. Under the industrial expansion of the Soviet five-year plans, Tashkent became a textile-manufacturing center of importance. The completion of the Turkestan-Siberian railway in 1931 linked the city with the Trans-Siberian line and gave greater impetus to its growth. During World War II the influx of evacuées from European Russia doubled the city's population.

With the steady increase of population after the 1920's the city boundaries have been extended, and the old section with its low, mud-brick huts is confined to the southeastern area. Even in the newer districts which have concrete buildings the structures are kept low because of the numerous earthquakes occurring in the region. Tashkent has been a great cultural center of central Asia, with a state university, academy of sciences, institute of medicine, textiles institute, museum, opera house, and schools of drama, agriculture, technology, and industry. Experimental work is active in all phases of the cotton industry. Tashkent is on the Turkestan-Siberian Railway and is an important air terminal. The economic center of Soviet central Asia, the city has extensive trade in raw cotton and grain. The cotton mill, built in the 1930's, is one of the largest in Asia. Products include silk, leather goods, metalwares, tobacco products, chemicals, dressed meat, textile and agricultural machinery, steel, and flour. Pop. (est. 1954), 615,000. C. C. H.

**The Region.** Tashkent is delimited on the north by the South Kazakhstan Region, on the east by the Dzhalal-Abad and Namangan regions, on the south by the Leninabad and Ura-Tyube regions, and on the west by the Samarkand Region. The principal ethnic groups are the Uzbeks, a Turkic people of Moslem religion, but there is also a large minority of Russians settled mostly in urban communities. There are small groups of Kazakhs, Kirghizes, Tadzhiks, Armenians, and Jews. Much of the region in the Turan Lowlands is unreclaimed desert, but along the Chirchik River an extensive irrigation system has resulted in a heavy concentration of cotton, alfalfa, vegetables, and fruit (especially apricots, peaches, and grapes). Because the region is high and close to the Pamirs, it has an annual precipitation of 13 in. From a January average of 30° F., temperatures range to a July average of 80° F.; a maximum of 109° F. has been recorded. Foehn winds sweep down the valley of the Chirchik frequently during the winter months; as a result, December temperatures have at times hovered in the 80's. The region has industries, including textiles, the manufacture of cotton-cultivating machinery and trucks, and grain milling. In the vicinity of Chimkent are two electrochemical plants producing nitrogen fertilizer. Mineral resources are limited; at Almyk is a copper mine, and nearby a coal mine began to operate during World War II. Pop. (est. 1954), 1,400,000. D. L.

**TASHUNCA-UITCO** [tæshʌ′ŋkə wɪ′tko] (c. 1844-1877), popularly known as Crazy Horse, a prominent chief of the Oglala Sioux. He is said to have been given his name when a wild horse dashed through the encampment at the time of his birth. During his lifetime Crazy Horse became the most famous war leader of the southern Sioux, and was praised by Indians and whites alike as a strategist and tactician. When the Sioux went on the warpath in 1875 because of white occupancy of the Black Hills and other grievances, Crazy Horse and Sitting Bull were their leaders, the former leading the Oglala and the Cheyenne. He also participated in the Custer Massacre on the Little Big Horn. In 1876 Crazy Horse and his band surrendered to Gen. Nelson A. Miles. Suspected of stirring up another war, Crazy Horse was arrested in 1877 and shortly afterward was shot by his guards when he attempted to escape. H. T.

**TASK, THE,** by William Cowper, a poem in six books, which first appeared in 1785 and established Cowper's reputation as a poet. A friend, Lady Austen, suggested as a task the writing of a poem on the then new and fashionable article of furniture, the sofa—a circumstance that explains the title and the mock-epic opening of the poem. The remainder of the poem is a series of easy, informal essays in blank verse, containing descriptions of country life and of the landscape around Olney in various seasons, Cowper's opinions upon a vast range of subjects, including the state of society and of governments, and a thorough discussion of religious faith. S. F. F.

**TASMANIA** [tæzme′niə], a triangular-shaped island south of the eastern mainland of Australia and the smallest of the six states of the Australian Commonwealth, 26,215 sq. mi. in area, or 0.88 per cent of the total. The state includes the Macquarie Islands, 850 mi. to the southeast; King Island, about 50 mi. northwest; Hunter Island off the northwest point; the Furneaux Group off the northeast point; and Bruni Island off the southeast coast. Bass Strait, 185 mi. long, separates northern Tasmania from the south coast of Victoria; on the east coast the island is bordered by the Tasman Sea, a part of the South Pacific Ocean, and on the west and south coasts by the Indian Ocean.

**Geography.** *Topography.* Tasmania is essentially a continuation of the eastern highlands of Australia despite its separation from the mainland by the 80- to 150-mi. wide Bass Strait. Rugged mountains prevail in the west and northwest, the largest being Ben Lomond, 5,160 ft. high. These give way to a plateau 4,000 to 5,000 ft. above sea level in the center of the island. There are relatively small lowland plains in the north, east, and southwest. The principal rivers are the Tamar, in the north; the Derwent, in the central part of the island; the Gordon and Pieman, in the west; and the Arthur, in the northwest. There are many lakes in the central part of the island, including Great Lake, Lake St. Clair, Lake Sorell, and Lake Echo.

*Climate.* The climate is generally cool and moist, resembling that of New Zealand, southwest England, or the northwest coast of North America. There are, however, wide geographical variations in temperature and precipitation. In the lowlands the temperatures are moderate throughout the year, while those in the mountains and plateaus are much lower in winter. Rainfall ranges from less than 20 in. in the eastern part of the island to more than 130 in. on the west coast, which is fully exposed to the westerly storms.

**Population.** According to the census of 1947, Tasmania had a population of 257,117. About 29 per cent (76,567) of the total population lives in the state capital of Hobart. The other principal cities are Launceston, with a population of

40,449; Burnie, 7,237; and Devonport, 6,156. The population is almost entirely of British origin, the last of the pure-blooded Tasmanian aborigines having died in 1876.

**Government.** *Administration.* At the head of the administration is a governor appointed by the British Crown, who in 1950 was Admiral Sir Hugh Binney. A Legislative Council and a House of Assembly constitutes the Parliament. The Council comprises a total of 19 members who sit for a six-year period, and the House of Assembly has 30 members who are elected for five-year periods.

*Finance.* The last fiscal year (1947-1948) for which exact figures were available showed an income of £A4,815,974 and expenditures of £A5,101,882. The public debt at the same time was £A33,957,333.

**Economic Resources and Activities.** The vegetative types of Tasmania include beech forest, temperate rain forest, park lands, pine forest, moors, and alpine growth. The soils vary from rich alluvial loams and basaltic soils in parts of the lowlands to shallow, stony unproductive soils in the rougher and higher country. Resources of metallic minerals include silver, gold, tin, zinc, lead, copper, iron, and osmiridium in western Tasmania, and nonmetallic deposits of coal, limestone, clay, and oil shale in the east and north.

Apples, wheat, oats, peas, potatoes, and hay are among the chief agricultural output. In 1946-1947 the net value of agricultural and pastoral products was £A8,120,280.

For the same period the net value of manufactures was £A10,668,000, and of mining products, £A2,858,270.

**Social and Cultural Activities.** *Education.* Free and compulsory primary education in 1947 was given in 334 schools to about 34,000 children. Secondary education is provided in both state high schools and privately endowed schools, and in 1947 was given in 7 state high schools with a student enrollment of 2,240. Besides a number of technical schools, there is the University of Tasmania with 663 students in 1947, which was founded at Hobart in 1890.

*Social Services.* Pensions for old age and invalidity are paid by the Commonwealth Government, which also supports hospitals in conjunction with the state.

**History.** Tasmania was discovered Nov. 22, 1642, by the Dutch mariner Abel Janszoon Tasman, who had been sent by Anton Van Diemen, governor general of the Dutch East Indies, on an exploring expedition to Australian waters. Tasman named the region Van Diemen's Land in honor of his patron, but he was not aware of the insularity of the land he had discovered. Although Captain James Cook touched there in 1777, he likewise did not realize that Van Diemen's Land was an island. In 1798 the English explorer George Bass was provided with a whaleboat in which he made a voyage to Westernport on the mainland of Australia and satisfied himself that there was a strait between Australia and Van Diemen's Land. Later in the same year Bass and Matthew Flinders, an English mariner and hydrographer, circumnavigated the island.

*Mount Wellington above the harbor at Hobart, capital of Tasmania*

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Settlements of the island were made in 1803 and 1804 by the English, and it became a dependency of New South Wales. Later, in 1807, a penal colony was established near the present site of Hobart. In 1825 a separation from New South Wales was brought about and Van Diemen's Land was granted a form of government like that of the parent colony. In honor of its discoverer, the name Tasmania was chosen in 1853, and three years later a system of responsible government came into being.

About this time a gold rush caused considerable emigration from Tasmania to Victoria, and an increase in exports to the same colony. Unsuccessful attempts were made to induce more people to take up land in Tasmania for agricultural purposes. The adoption of protection by Victoria only increased the difficulties of Tasmania. The discovery of tin and gold in the 1870's, together with an increased interest in agriculture and sheepraising, helped to bring the colony out of its depressed condition.

The voters of Tasmania gave strong support in the referendums on the constitution for the Australian Commonwealth in 1898 and 1899, and on Jan. 1, 1901, Tasmania was federated with the other Australian states into the Commonwealth of Australia. R. G. B. and R. V. S.

**TASMANIAN DEVIL,** a thickset, powerful marsupial, *Sarcophilus ursinus,* now restricted to Tasmania. It is the size of a large house cat and is covered with coarse black hair, but it has irregular blotches of white on the shoulders, throat,

and rump. Except for the long tail, it resembles a miniature bear in appearance. It is savage and quite untamable. The animal is destructive of other native marsupials and livestock, including sheep. It has been relentlessly hunted, and has become extinct in southern Australia. In spite of its relatively small size, the Tasmanian devil is provided with a formidable dentition and is a dangerous foe for much larger sheep dogs.

W. J. Ha.

**TASMANIAN WOLF,** largest and most formidable of living, carnivorous marsupials. The general appearance is doglike, the hind end of the body gradually tapering to the tail. The grayish-brown coat is marked with dark brown bands across the back and hindquarters. The single species, *Thylacynus cynocephalus,* is now restricted to the wilder parts of Tasmania. Formerly abundant, it has been greatly reduced by the settlers in retribution for its attacks on poultry and sheep. While the Tasmanian wolf or "tiger," as it is often called, will not attack man, it is more than a match for a dog of comparable size. It inhabits hilly, forest country, hunting in pairs during the evening. The young are carried in the pouch for 3 months, and then deposited in a den until the cubs are able to shift for themselves. W. J. Ha.

**TASSEL FLOWER,** a common garden annual, *Emilia sagittata,* of the family Compositae, also called Flora's-paintbrush. It is probably a native of the American tropics and is very easily cultivated. The erect hairy stem, 1 to 2 ft. high, bears lance-shaped leaves clasping the stem, and clusters of small scarlet flower-heads from July until frost.

J. C. Wis.

**TASSIGNY, JEAN JOSEPH MARIE GABRIEL DE LATTRE DE** [ta'si'nyi'] (1889-1952), French Resistance leader and Allied general of World War II, was born on Feb. 2, 1889, in Mouilleron-en-Pareds in Vendée, where his father was mayor. He served in World War I, which commenced a year after his graduation from the military academy at St. Cyr, and advanced from the rank of second lieutenant to that of captain. When in 1939 De Lattre became the youngest brigadier general in the French Army, he had fought under Lyautey in Morocco, had completed the staff and advanced staff courses of the Ecole Supérieure de Guerre and the Centre des Hautes Etudes Militaires in Paris, had commanded an infantry regiment, and in addition had served as General Weygand's chief of staff.

In World War II, De Lattre blocked the German offensive in Alsace until the Pétain armistice. Condemned to ten years in prison in November 1942 for his resistance to the Nazis, he escaped in September 1943. In December, De Lattre joined General Charles de Gaulle in Algiers and was made a full general and commander in chief of all French forces in North Africa. He headed the newly organized French First Army and the 36th American Division from October 1944 until May 9, 1945, the day he signed for France the documents of German surrender. In July 1945, after heading the French army of occupation and representing France on the Inter-Allied Control Commission at Berlin, he was appointed inspector general of French ground forces and in May 1948, inspector general of all French forces. In December 1950 General De Lattre was made High Commissioner and commander of French forces in Indochina, and under his leadership considerable advance was made in the fighting against the Communists. He died in Paris on Jan. 11, 1952.

M. C. C.

**TASSO, TORQUATO** [tɑ'sso; tæ'sso] (1544-1595), Italian poet of the late Renaissance, was born March 11, 1544, at Sorrento. His father, Bernardo Tasso, was a scholar and a poet, and secretary to the Prince of Salerno. In the latter city and in Naples, Torquato and his sister spent their early youth. When the boy was ten, his father went into exile with his patron, who had been condemned as a rebel against the Spanish viceroy. Soon after, Torquato left his mother, whom he was never to see again, and joined his father in order to pursue his studies. He received an excellent education, enhanced by the proximity of Renaissance court life, to which he felt peculiarly attracted. At Urbino he served as companion to the young heir to the dukedom, and at this court, Tasso became imbued with the honored ideals of the chivalric code and courteous behavior. He moved delightedly in this atmosphere of refined elegance and dreamed of spending a happy existence as the protégé of some generous and learned patron. A part of Tasso's tragedy was that he could neither completely fulfill nor wholly abandon this splendid dream.

In Venice, Torquato helped his father prepare for publication the chivalric poem, *Amadigi,* on which Bernardo had worked for years, and began to turn over in his mind epic subjects which he himself might treat. But Bernardo sent him to study law at Padua, where he came under the influence of Scipione Gonzaga, Sperone Speroni, and Carlo Sigonio, and acquired a taste for philosophy and critical theory. Here also he began to publish lyric verse and composed a romantic narrative poem, *Rinaldo,* which was printed in 1562, when Tasso was only eighteen years old. In 1565 he went to Ferrara and entered the service of Cardinal Luigi d'Este, brother

TORQUATO TASSO

CULVER SERVICE

of Duke Alfonso II. He plunged with delight into the splendid life of the gay little capital. After a brief journey to Paris in 1570-1571 in the retinue of Luigi, he entered the service of Duke Alfonso himself, as court poet. Admired, pampered, envied by those about him, pleased with his new independence and the freedom to develop his natural talents, Tasso now spent several happy years, the last that he was to know. He wrote amorous lyrics to various ladies of the court. He composed, in a few weeks and with little effort, the five acts of his *Aminta,* a pastoral drama or woodland fable. The play, one of the best of its kind, was performed in 1573 before the court. While still sustained by the exaltation of this success and the increasing recognition of his poetic genius, Tasso completed, in 1575, the composition of his masterwork, the noble and harmonious epic poem, *Gerusalemme Liberata* ("Jerusalem Delivered"). These labors seem to have had a deleterious effect on the nerves and mind of the over-sensitive poet. He developed an abnormal sus-

ceptibility to criticism; he suffered from excessive religious scruples; he came to believe that he was being persecuted by envious courtiers. After several violent outbreaks of temper he was confined in 1579 as a madman in the prison of Sant'Anna in Ferrara, where he spent seven wretched years. This circumstance soon gave rise to a legend which attributed the cause of his misfortunes to a mad passion for Leonora d'Este, the Duke's sister, and to the Duke's desire for revenge. This legend lent added pathos to the figure of the unfortunate poet, who became a symbol of misunderstood genius and furnished a subject for many romantic works of art and literature.

During his incarceration Tasso continued, in his lucid moments, to write lyric poems and treatises in dialogue form on literary and philosophical subjects. His *Aminta* and *Gerusalemme liberata* were published in 1581, without his authorization, and gained immediate popularity. *Gerusalemme liberata* aroused long and bitter discussions among the critics, who disapproved of Tasso's attempt to reconcile Ariosto and Virgil in his conception of the heroic poem.

Tasso was finally liberated in 1586. During the remaining nine years of his life he appeared as a pathetic figure, wandering restlessly throughout Italy, his health broken, his genius spent. He found temporary refuge with various protectors, whom he celebrated in verse, including G. B. Manso, who was to write his first biography, and Cardinals Pietro and Cintio Aldobrandini, to whom he dedicated his *Gerusalemme conquistata,* a tiresome reworking of the *Gerusalemme liberata.* Pope Clement VIII finally granted him a pension, promising to confer upon him the laurel crown. But the ceremony was repeatedly postponed, and death robbed the unhappy poet of this last honor. He died on April 25, 1595, in the monastery of Sant' Onofrio in Rome and was buried in the chapel there. His grave was destined to become a place of pilgrimage for many generations of admirers.

Tasso's complete works fill several large volumes and include, besides those already mentioned, innumerable sonnets, many of which are excellent, numerous letters, a tragedy, *Torrismondo,* a poem on the creation of the world entitled *Le Sette giornate,* smaller poems of unequal worth, and the important *Discorsi dell' arte poetica.*

Tasso was a poet astride two ages. His tastes and aspirations were those of the high Italian Renaissance before the Council of Trent; but he lived his mature years during the Counter-Reformation. However, he made a serious effort to conform and to become the poet of his era. A sincere Christian strain may be traced throughout his work, but it does not go deep. It produces at most a general religious coloring and a few heartfelt accents. There is nothing of the mystic or the Puritan in Tasso, and he was rather the victim than the typical singer of his age. The deepest note in his poetry is not religious, but passionate and lyrical. The conflict between his temperament and his times, as well as between his dreams and the harsh realities of his experience, left its mark on his whole life and work, and accounts for most of the shortcomings of the poet and the tragic appeal of the man. *See also* Aminta; Gerusalemme Liberata. C. B. B.

**TASTE.** *See* Comparative Anatomy; Mammal (*Nervous System*); Sensation.

**TATAR.** *See* Asiatic Tribes (*Ural-Altaic*).

**TATAR AUTONOMOUS SOVIET SOCIALIST REPUBLIC** [tɑ′tər], a territorial-political unit of the west central Russian Soviet Federated Socialist Republic of the Soviet Union. Its area of 25,900 sq. mi. is bounded on the north by the Mari and Udmurt Autonomous Soviet Socialist Republics and the Kirov Region; on the east by the Bashkir Autonomous Soviet Socialist Republic; on the south by the Chkalov, Kuibyshev, and Ulyanovsk regions; and on the west by the Chuvash Autonomous Soviet Socialist Republic. The principal ethnic groups of the republic, which was established in 1922, are Tatars (50.5 per cent, predominantly rural) and Russians (42 per cent, urban). The Tatars are Moslems of Turco-Tatar stock. Culturally they are considered the most advanced Moslem nationality in the Soviet Union. Kazan, the capital, is the center of Tatar cultural life.

Poor podsols and sandy soils are found in the republic, except in the southwest, where fertile black soils occur. The climate is one of continental extremes and an undependable rainfall of about 15 in. annually. Despite these handicaps the republic is predominantly agricultural. There are important acreages of spring wheat, winter rye, buckwheat, peas, chicory, potatoes, and sunflowers. The agriculture has been collectivized almost completely. In industry the Tatar Republic leads the Soviet Union in the processing of furs. Also significant are the production of soap and candles, and the manufacture of felt boots, asphalt, and typewriters. Pop. (est. 1954), 3,200,000. D. L.

**TATE.** *See* Asiatic Tribes (*Indo-Iranian*).

**TATE, ALLEN** (1899- ), American critic and poet, was born in Clark County, Ky., Nov. 19, 1899. He graduated from Vanderbilt University in 1922, and, as a teacher, has been associated with several colleges, notably as Fellow in Creative Writing at Princeton, 1939-1942. In 1944 he became professor of English at the University of the South and editor of the *Sewanee Review.* Tate's sectionalism is demonstrated in *Stonewall Jackson—The Good Soldier* (1928), *Jefferson Davis—His Rise and Fall* (1929), his novel *The Fathers* (1938), and his essays for the Agrarians. His verse, influenced by John Donne and T. S. Eliot, is represented in *Poems, 1920-1945* (1946). *Reactionary Essays in Poetry and Ideas* (1936) and *Reason in Madness* (1941) illustrate his antihistorical method of literary criticism. G. C. K.

**TATIUS, ACHILLES.** *See* Achilles Tatius of Alexandria.

**TATLER, THE.** *See* Steele, Sir Richard.

**TATONAY.** *See* Edentata.

**TATSIENGLU.** *See* Kangting.

**TATTI, JACOPO.** *See* Sansovino, Jacopo.

**TATUNG** [dɑ′tʊ′ŋ], a railway town in the northern part of Shansi Province in east central China, situated on the west bank of the Yu Ho, at the junction of the Peiping-Suiyuan (Peiping to Paotow) and the Tung-Pu (from Tatung to Fenglingtu) railways. The town is built on a level plain 3,445 ft. above sea level, with the Heng Shan rising to the south and a spur of the Yin Shan range in the north. Tatung was the capital of the Northern Wei dynasty for the period A.D. 386-493. For the Liao (Khitan) Dynasty (A.D. 907-1154) and the Chin (Golden) Dynasty (A.D. 1115-1234), Tatung was their Western Capital. During the Ch'ing (Manchu) Dynasty (A.D. 1644-1912), when the town was known as Tatungfu, it was the site of a prefectural government. Tatung is a trading point, importing sheep, camels, fur, skins, and wool from Inner Mongolia and exporting tea, silk, cotton piece goods, and the rich agricultural products from the Fen River Valley (in Shansi Province) to Mongolia. However,

Tatung is primarily important as a coal center. To the southeast of Tatung, at Kowchuan, lies a coal reserve estimated at 40,000,000 tons of high quality coal. Glass manufacturing is an ancient industry of the town, dating back to the days of the Northern Wei Dynasty. The art of glass making was later perfected by Persian artisans who found their way to this part of China at the beginning of the fifth century. Pop. (est.), 50,000. A. C. T.

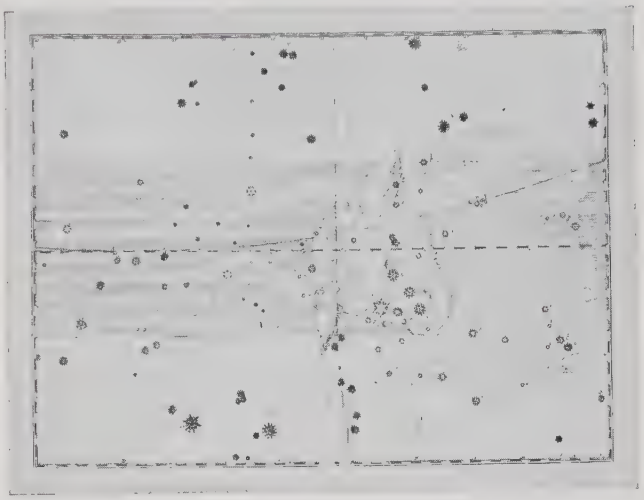
**TAUERN** [tau′ərn], a mountain range lying east of the Brenner Pass in the central Austrian Alps. The Hohe Tauern consists of granite gneiss rock and contains Gross Glockner, 12,457 ft., Austria's highest peak, as well as several other mountains above 12,000 ft. With a length of 83 mi. and a width of 30 mi., it is crossed via the Tauern Tunnel by a railway linking Salzburg and Carinthia. To the north is the Salzach River, flowing into the Inn, and to the south, the Drau flowing into Yugoslavia, where it is called the Drava, and finally into the Danube (Dunav). The snow line exists at from 9,000 to 9,500 ft. elevation. The region is a noted tourist center and many famous hotels are located here.

The Niedere Tauern, east of the Hohe Tauern, lies between the Enns and the Mürz river systems and is crossed by the Radstädter Tauern Pass (5,700 ft.) linking Salzburg with southeastern Austria. The region is a noted sports center and contains several peaks exceeding 9,000 ft. in height, including Hochgolling, 9,392 ft., and Hohe Wildstelle, 9,010 ft. S. Van V.

**TAUNTON** [tɑ′ntən; tɔ′ntən], a municipal and parliamentary borough, the county town of Somersetshire, England, in the Tone River Valley, 130 mi. southwest of London. It is a market town for the surrounding district, known as Taunton Deane, famous for apples and cider. Woolen textiles, leather goods, and plastics are manufactured, but farming is an important occupation. Coins dug up in the seventeenth century indicate a Roman settlement there. In Saxon times Taunton was of some importance. A Saxon king built a castle in Taunton which was later demolished. The community received a charter of incorporation in 1627 from Charles I, but this charter was taken away by Charles II in 1660, the year in which the town's walls were destroyed. In 1677 Charles II issued another charter reincorporating Taunton. Of the twelfth-century castle dismantled during the Restoration, enough remains to house a museum. Norman and early English features are distinguishable in the parish church, and among other antiquities are a notable market cross and the scant remains of a priory founded in the reign of Henry I. Pop. 1952, 34,600. A. W.

**TAUNTON,** a city in southeastern Massachusetts, the county seat of Bristol Co., situated on the Taunton River, at the head of ocean navigation, 36 mi. south of Boston. Taunton was settled by colonists from the Massachusetts Bay Colony and first known as Cohannet, but it was renamed later in honor of Taunton, England. It was incorporated as a town in 1639 and as a city in 1864. When the Boston Port Act was passed in 1774, the people of Taunton, led by Robert Treat Paine, a signer of the Declaration of Independence, showed their sympathy for Boston by hoisting on the village green the British "Red Meteor" flag bearing the words "Liberty and Union." Reed and Barton established their silverware business in Taunton in 1824; the Rogers Silverware Company was incorporated in 1883; and Isaac Babbitt, inventor of "Babbitt metal," produced Britannia ware in Taunton. The city is the seat of a state hospital for the insane. The New York, New Haven and Hartford Railroad serves the community. Principal manufactures include silverware, textiles, textile machinery, stove linings, crucibles, and bricks. Pop. 1950, 40,109.

**TAURUS** [tɔ′rəs], the Bull, a large ancient constellation, located immediately north of the celestial equator, and with its center in right ascension at about 4 hr. 30 min. Its symbol ♉ is the second sign of the zodiac, which the sun enters on April 20. Within its boundaries are the Pleiades



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*TAURUS, THE BULL*

and the Hyades. The latter is a V-shaped figure of stars, all of which are faint with the exception of Aldebaran, at the upper part of the left branch. When in the west, the V stands upright. In constellation figures, the Pleiades are in the shoulder of the Bull with the Hyades in his face. Aldebaran represents his eye. As is usual with animal constellations, only the front half of the Bull is depicted by stars. Taurus is rich in telescopic double stars. About 1° north of the star Zeta is the noted Crab nebula. Chinese records indicate that a brilliant nova appeared in this general location in A.D. 1054, and the nebula is expanding at a rate which would place its beginning at about that date.

In mythology, Taurus was the snow-white bull which carried Europa to Crete. The Pleiades were seven sisters, daughters of Atlas; the Hyades, their half sisters. *See also* ALDEBARAN; PLEIADES. J. H. P.

**TAURUS,** a range of mountains in southern Turkey that extends in an east-west direction parallel to the Mediterranean sea coast. The mountains are folded ranges, arranged in echelon, and the maximum elevations are between 10,000 and 11,000 ft. These mountains form a spectacularly beautiful wall that cuts off the Anatolian Plateau from the Mediterranean Sea; and drowned spurs of the Taurus form some of the islands of the Aegean Sea. In the east the mountains bend to a northeast-southwest direction and eventually join the Armenian Knot. The Taurus Range is paralleled in the east by the Anti-Taurus Range. J. E. F.

**TAUSSIG, FRANK WILLIAM** [tau′sɪg] (1859-1940), American economist, was born at St. Louis, Mo., Dec. 28, 1859. He was educated in the local schools, attended Washington University in St. Louis, graduated from Harvard University (1879) and studied at the University of Berlin.

He was appointed an instructor in economics at Harvard University in 1882, becoming professor of political economy in 1892, Henry Lee Professor in 1901 and Henry Lee Professor Emeritus in 1935. He was editor of the *Quarterly Journal of Economics* from 1896 to 1937. He concentrated his attention on finance and the tariff, was president of the American Economic Association in 1904-1905 and helped organize the Harvard Graduate School of Business Administration, 1906-1907. Taussig was chairman of the United States Tariff Commission in 1917-1919, a delegate to the Paris Peace Conference in 1919, a member of the President's Industrial Conference in 1919-1920, and a member of the Sugar Equalization Board from 1919 to 1926. He was the author of *The Tariff History of the United States* (1888), *Wages and Capital* (1896), *Principles of Economics* (1911), and other similar books and articles on economics and finance. Taussig died at Cambridge, Mass., Nov. 11, 1940. T. R. H.

**TAUTOG.** *See* Blackfish.

**TAWACONI.** *See* Indian Tribes, North American (*Southeast*).

**TAXATION,** the act of raising revenues by levying charges against persons and property; the method of determining and making such charges for the support of government; and the amounts levied, which are known as taxes. A tax is a compulsory contribution from the wealth of a person or body of persons for the service of the public powers. There are three important elements in this definition. First, tax payment is compulsory. The power to tax is an attribute of sovereignty and hence is not to be neglected or ignored by the persons subject thereto. Second, taxes are paid by individuals. They may be levied on property or on objects animate or inanimate, but the obligation to pay is always upon a person or upon a body of persons such as a corporation. Third, taxes are collected for the service of the public powers, which means the support of the services and activities undertaken by government.

## DEVELOPMENT OF TAXATION

**Ancient Collection Methods.** Some method or other whereby the constituted public authorities have drawn for their support upon the resources of the people has existed since the beginnings of organized government. One of the earliest manifestations of the division of labor was that between the governors and the governed. The duty of the governed was to obey orders and to supply the governors with the means of their support. The manner in which the people have supported the government has varied in different historical epochs and with changing economic conditions. In ancient times, the contributions were largely in kind. The priesthood, which emerged as the first governing body of the Hebrews after the escape from Egypt, was supported by a tithing system under which a percentage—usually a tenth—of the increase of the flocks and herds was given. Under the monarchy that supplanted the priesthood in the administration of secular affairs, public revenues were collected both in kind and in money. The drain upon the people's resources had become so heavy by the end of King Solomon's reign as to lead to protests and pleas for relief when Rehoboam succeeded to the throne. The appeals were dismissed and still heavier exactions were threatened.

Studies of Egypt under Roman rule reveal an array of taxes similar to the multiplicity of taxes in modern times. Levies included a land tax, collected in kind from grain land and in money from vine and garden land; poll taxes; taxes on animals, trades, industries, and fishing, and on sales of various goods; and import and export duties. The use of money for taxes in the time of Christ is indicated by His answer to the question whether or not it was lawful to give tribute to Caesar. The answer was: "Render under Caesar the things that are Caesar's," that is, the money bearing his image and superscription (Mark xii: 17).

**Growth of Money Economy.** After the decay of the Roman Empire, Europe passed into the long decline of the Dark Ages. This was a period of strife among the many small states and principalities which were the fragments of the empire. Taxation as such ceased to be a major source of governmental support, and, instead, the concept of feudalism evolved.

The growth of a price and market system as a money economy expanded led to the collection of a greater proportion of the public revenues in money rather than in kind. Even so, there was relatively little use of taxation to obtain the money for public use except in England, where feudalism decayed earliest and most completely. It is significant of the slow economic development of continental Europe that as late as the third quarter of the eighteenth century the leading cameralist writers of the time could still give first place, as a source of public support, to the revenues from the crown domains, with the regalian, or royal privilege, revenues second and taxation third. By this time, also, the doctrine of mercantilism had degenerated into the concept that money, as such, is the most important form of wealth.

In 1776, Adam Smith, however, attacked the old economic systems and ideas in his book *An Inquiry into the Nature and Causes of the Wealth of Nations.* He completely demolished the reasoning which supported the then-current policy of state control and planning, and the notion that government, through its acts and decisions, could increase the wealth of the nation. He demonstrated that the wealth and strength of a nation rest upon the wealth and economic capacity of the citizens. He may have been familiar with Colbert's famous phrase, *"Il faut laisser faire les hommes,"* although the expression *laisser* (*laissez*) *faire* does not occur in his book. But he demonstrated that the state should leave its citizens free to seek their economic advantage wherever and however, in lawful ways, the prospect of gain might lead them, at home or abroad. The state whose citizens are wealthy and prosperous is a strong state. Such a state is strong because it can draw upon the wealth and income of its citizens through taxation to meet the public needs. Smith reversed the counsel of the cameralists by putting taxation first instead of last in the sources of public revenue. He advised sale of the sovereign's domain and use of the proceeds to redeem the public debt. This viewpoint may have influenced the early policy followed by the United States Government with respect to the public lands and the national debt.

Smith's theories pointed to the conclusion that the state should leave its citizens as free as possible to gain wealth and income, and that it should derive its own support from taxes levied on the incomes and wealth of the people. But it must not be inferred that this advice pointed to reckless, punitive, discriminatory, or wasteful taxation. Smith laid down certain maxims or canons of taxation which he believed should guide the state in its exercise of the taxing power. These may be characterized as, equality, certainty, convenience, and economy.

In brief, these maxims mean that there must be equality in the distribution of the tax burden; that the amount each person is to pay should be certain and definite; that the time

and manner of payment should be as convenient for the taxpayer as possible; and that the administrative costs should be held down to the minimum.

**Tax Reforms in the French Revolution.** Taxation under the old regime was one of the many causes of the unrest which produced the French Revolution. It was one of the subjects of thoroughgoing reform and revision when the blood purge ended and the Assembly settled down to constructive business. The new taxes, which were destined to form the framework of the French revenue system until the financial strain of World War I compelled a change, were established on certain broad principles that may be summarized as follows:

(1) Objectivity. This means that the tax base must be one capable of objective determination, as by measuring, weighing, or counting, so that neither the personality, nor the social standing, nor the private personal affairs of the taxpayer need be considered in the assessment, levy, and collection of the tax.

(2) Proportionality. This principle was a direct outgrowth of the revolutionary slogan of equality. To the revolutionists, it meant that the rich should pay the same rate of tax as the poor.

(3) Definiteness. This principle was aimed, as was Smith's maxim of certainty, at the vicious practice of "tax farming." Under this practice, tax collections were farmed out as concessions. The concessionaire paid a fixed sum to the treasury and kept all that could be extorted above the contract payment. This extortion, or squeezing, was done efficiently and hence was lucrative. The Assembly ended this practice by setting, particularly for the land tax, fixed quotas to be collected, and allocating to each governmental subdivision its share of the total.

**English Revolt Against Arbitrary Power.** A substantial contribution to taxation theory and practice, apart from the influence of Adam Smith, was made by English experience. In one particularly important aspect, namely the constitutional side of taxation, the developments in England were of paramount significance. The patrimony of the state includes not only its natural resources of land, water, minerals, and so on, but also the productive capacity of the citizens. The early resistance of the English people to the efforts of the vested ruling interests to levy at will upon the product of their work was one of the steps in the evolution of the taxing power.

*Magna Carta.* Such rudimentary elements of a democratic system as the Saxons may have developed in England were supplanted, after the Norman conquest, by a feudal system on the European model. The successors of William I extended and increased their exactions and also their claims to autocratic power until, in 1215, a showdown came at Runnymede, where King John was forced to sign the first great charter (Magna Carta) defining the rights of Englishmen. This great charter contained some restrictions on the king's power to impose the thirteenth century equivalent of taxes. These were stated as follows: "No scutage or aid shall be imposed in our Kingdom except by the common council of our Kingdom, except for the ransoming of our body, for the making our oldest son a knight, and for once marrying our oldest daughter, and for these purposes it shall be only a reasonable aid."

*Bill of Rights.* The next great landmark in the evolution of the principle that sovereignty, and hence the taxing power, resides in the people, not in the ruler, came in the Bill of Rights of 1689. The following passage relates to taxation: " . . . levying money to or for the use of the Crown by pretense of prerogative without grant of Parliament for longer time or in other manner than the same is or shall be granted, is illegal."

The Bill of Rights did not establish Parliamentary control over all aspects of the public finances. Thus, it did not provide for control of spending or of public debt. Even in modern times the people have been deprived of their constitutional right of control over the public purse by inordinate spending financed by increasing the public debt. In practice, therefore, the limitation quoted above was not too effective immediately in keeping down governmental costs. But it did put an end, once and for all, to such unwise measures as King Charles I had undertaken: namely, to decree and levy taxes without Parliamentary consent. It gave full authority to the evolving concept that the people, through Parliament, had the power to pass upon tax levies. Thus was completed the first stage in the evolution of constitutional government. The core of this evolution is determination of the locus of the power to tax. Where that power resides, there resides sovereignty.

**Tax Provisions of the United States Constitution.** This record should make it easier to understand why English colonists in America nearly a century later, should resent taxes levied upon them by a Parliament in which they were not represented. They knew that there had been a revolution in 1688 in which the last weak remnant of the Stuart family had been dethroned, and out of which had come the Bill of Rights, applicable to all Englishmen everywhere. When the Constitution of the United States was written, the promise that the sovereign power, in all its aspects, was in the people was accepted as a matter of course. The provisions relating to taxation are:

Art. I, Sec. viii, par. 1: "The Congress shall have power to lay and collect taxes, duties, imposts, and excises, to pay the debts and provide for the common defense and general welfare of the United States; but all duties, imposts, and excises shall be uniform throughout the United States."

Art. I, Sec. ix, par. 4: "No capitation or other direct tax shall be laid unless in proportion to the census or enumeration herein before directed to be taken."

Art. I, Sec. ix, par. 5: "No tax or duty shall be laid on articles exported from any state."

Art. I, Sec. x, par. 2: "No state shall, without the consent of the Congress, lay any imposts or duties on imports or exports, except what may be absolutely necessary for executing its inspection laws; and the net produce of all duties and imposts, laid by any state on imports or exports, shall be for the use of the Treasury of the United States; and all such laws shall be subject to the revision and control of the Congress."

In the process of judicial interpretation, various other provisions of the Constitution have been held applicable to taxation, although their original intent may have been otherwise. For example, the states may not burden interstate commerce by taxation. No state may, by taxation, contravene the provisions of federal treaties. Neither federal nor state governments may, by taxation, interfere with the essential operations of the other. To make the popular control over the purse more secure, it was provided that bills for raising revenue must originate in the House of Representatives, which was then expected to be more closely and directly representative of the people than the Senate.

**Tax Jurisdiction.** One of the most difficult questions in taxation is the determination of what persons or what things a government has the right to tax. One answer would be that this right extends to all persons or things within its

jurisdiction, but there still remains the problem of the circumstances that indicate whether the person or the object sought to be taxed is within the jurisdiction.

*Real Property.* The historic rule with respect to "things" was that real property was taxed where situated, while personal or movable property was taxed at the domicile of the owner. Many classes of tangible personal property, such as merchandise, livestock, and tools are taxed where located, regardless of the owner's domicile. Even intangible property, such as bonds, stocks, mortgage notes, and bank credits may be taxed at situs if it can be established that they are held there for purposes connected with business operations.

*Income.* Income presents a problem because it may originate in one jurisdiction while the recipient may live in another. Each government would have a legitimate claim, but if both exercised it there would be double taxation of that particular income. The solution is to establish, as a uniform procedure, either the rule of situs or that of domicile. Under the former, a government would tax all income originating within its jurisdiction, regardless of where the owner lived. Under the latter, a government would tax its residents on their income from all sources, and would not tax nonresidents at all. The compromise solution that has been most generally reached is to tax nonresidents on the income received within the taxing jurisdiction, but with reciprocal provisions either for exemption or for an appropriate tax credit on account of the taxes paid to the jurisdiction of residence.

*Inheritance.* In the case of the death taxes, the problem has become particularly acute in the United States because of Supreme Court rulings that a person may have more than one domicile. The states have been quick to seize upon this judicial viewpoint to levy double or multiple inheritance taxes upon large estates.

## DISTRIBUTION OF THE TAX BURDEN

No fixed rule can be given for the distribution of the tax burden among the citizens. Since the power to tax is vested in the people, it is reasonable to say that they incline to equality of taxation as a standard. In a democratic society there is general emphasis upon equality, expressed in such terms as the equal protection of the laws, equality of such privileges as the use of the public highways and public schools, equal voting rights, and so on. It is logical to set against this equality of protection and privileges an equality of responsibility for the support of government through taxation. On this premise, the difficulty is to find a practical test or standard of equality. The two principal solutions that have been developed are: (1) taxation according to benefit, and (2) taxation according to ability.

**Taxation According to Benefits Received.** According to the benefit standard, the citizens would contribute to governmental costs in relation to the benefits which they respectively received. Some payments are made on this basis. Examples are the special assessment, which is levied to defray the costs of improvements that benefit property; the charges made by the Post Office, the registrar of deeds, and the various licensing bureaus; and also the tolls paid for using special public facilities such as tunnels, bridges, and express highways. A certain part of the governmental expense can be covered by charges against the persons benefited, but there are other elements of this expense which involve common or general benefit rather than specific, measurable benefit to particular individuals.

**Taxation According to Ability.** The first strong impetus toward ability as a standard of equality was given by Adam Smith, who used the term in the first of his maxims on taxation. On this he wrote in part as follows: "The subjects of every state ought to contribute towards the support of the government, as nearly as possible, in proportion to their respective abilities; that is, in proportion to the revenue which they respectively enjoy under the protection of the state. . . . In the observance or neglect of this maxim consists what is called the equality of taxation."

According to this view, equality of taxation is attained when the citizens are contributing to the support of government in proportion to their respective abilities. Neither ability nor revenue is defined, but it is clear that Smith thought of a direct proportional relationship between them. That is, ability is a direct, proportional function of revenue. It is altogether probable that revenue meant, to Smith, the total income of the individual. There is nothing to indicate that he had in mind the "individual net income" of modern tax laws.

Application of the simple test of equality suggested in Smith's first maxim would be possible only by collecting all tax revenue through a single levy on incomes. This was not done, even in Smith's time. It would be quite impractical today, in view of the immense sums needed, despite the economic fact that all taxes, however imposed, are paid out of income. It has turned out, therefore, that the concept of ability has had little attention except in connection with the income tax.

A consequence of the overemphasis upon ability in the taxation of income is that it has led to a nearly universal belief that the rates of this tax must be steeply graduated or progressive in order to constitute an application of the ability principle. It is clear that the amount of ability that anyone has, in the sense under consideration, depends upon the amount of his income. A person with $4,000 of income a year has double the ability of another person with an annual income of $2,000. This is obviously true since each dollar of income can be spent only once. There is no multiplier that enables the recipient of a large income to spend the same dollars several times and still have them. The ability to buy anything, to pay rent or doctor's bills, to spend for any other purpose, or to pay taxes, is strictly proportional to income. Opposed to this viewpoint is one which says that ability increases faster than income. It says that the person with $12,000 income a year has more than six times the ability of one with $2,000 income a year, although he has only six times as many dollars of income in the same period.

One of the arguments advanced by advocates of progressive taxation is that enough is left out of the middle and larger incomes, even after payment of drastic progressive taxes, to meet the reasonable consumption requirements of the recipients. Proponents of a strictly proportional plan have answered this "cost of living" argument by declaring that there is another highly important function of income, which is the creation of more and better capital through saving and investment.

It must be emphasized that, apart from a philosophical search for a general principle such as equality, the particular manner in which a given state or nation may decide to apportion its tax load among its citizens is a matter of policy to be determined according to circumstances and conditions. For example, some of the states of the United States have consistently refused to introduce a state income tax. In others, an income tax would be quite unproductive. Some states limit the property tax to real estate; others tax both personal and real property. It is conceded that there is no one absolute standard by which to prescribe what and whom to tax. It is

also generally recognized that the one important thing to watch is the effect of the taxes selected upon the long-run prosperity of the people.

**Double Taxation.** Another aspect of the distribution of the tax burden is presented by double taxation. The term is most commonly used to mean the taxation of the same object by two co-ordinate jurisdictions, such as two states or two national governments. It can also mean taxation of the same object twice, or in two ways, by the same government. Taxation of the same object, such as property or income, by federal and state governments, or by a state and its cities, is not regarded as double taxation in the objectionable sense, for it is realized that all levels of government must draw their support from the same body of taxpayers.

The principal objections to double taxation are: first, that it is discriminatory, since the double burden is not spread among all, but only among those who happen to be caught in certain circumstances; and, second, that it imposes a heavier burden upon some than upon others because of the lack of universality. The problem is best dealt with by reciprocal arrangements under which some agreed basis for determining tax liability is accepted, such as residence in the case of the income tax. Tax agreements between the United States and other countries have ironed out many of the difficulties at the national level. Reciprocity and, in the case of business taxes, acceptance of a standard formula for allocating business income among the states have proved satisfactory measures at the state level. The federal law permits deduction of state taxes on income in determining taxable income. A conspicuous case of a government taxing the same thing twice is the federal rule requiring taxation of dividend income to shareholders in addition to the tax paid by the corporations on net income.

## SHIFTING AND INCIDENCE OF TAXATION

**General Economics of Exchanges.** It has long been understood that a tax which is imposed at one point may be transferred elsewhere. The transfer of the tax is called shifting and its coming to rest at some other point is called incidence. Both terms are needed to complete the concept, for there must be an eventual place where the burden is borne if there is a transfer or shift away from the point of original levy.

The transfer of a tax by the one who first pays it to someone else involves some kind of economic transaction between the two parties. Hence the economics of tax shifting lead into the field of exchange and price. The original taxpayer must be in a position to effect some kind of price adjustment, including wages as one form of price, in order to transfer the burden of the tax to another taxpayer. The manner of this transfer will be determined, usually, by the line of least resistance. A retail merchant, for example, may pass his tax on merchandise along to consumers by charging higher prices, or back to the wholesaler by insisting on reduced wholesale prices, or to his employees by wage reductions. The actual shifting of a tax is not as simple as this illustration may imply. The other party to the transaction always has his freedom of action also. The consumer may resist the higher prices, or the wholesaler may refuse to quote lower prices, or the workers may not accept the wage cut. A condition essential to tax shifting is that the imposition of the tax must introduce new circumstances under which price adjustments not theretofore possible have been made possible. Otherwise, the question arises as to why the merchant should delay increasing his prices until a tax is imposed, or until it has been increased. The answer must be that the introduction of the tax, or of a tax increase, has so changed the market situation as to open the way for tax shifting.

*Monopoly.* There are many who believe that a monopolist has no trouble whatever in shifting his taxes. It is true that he has control over the supply and can raise or lower it at will. But he does not have control over the prices that buyers will pay, or over the amount that they will buy.

*Competition.* Under competitive conditions no single producer or set of producers has control of the total supply. Each producer has his own costs of production, and there may be considerable variation. The market price for a commodity that is produced under such conditions may be a composite of all of the various cost factors. In a situation of this sort, and it is fairly typical of production conditions, the question arises of how it would be possible for a tax imposed upon producers to be shifted by them to the consumers. Perhaps the showing of a loss should be the signal for a prompt withdrawal from the unprofitable line, or for diversion into some more promising line.

In general, the conclusion appears reasonable that tax shifting does not occur easily and automatically. It has to come the hard way. In the long run, if taxes are so heavy as to prevent further capital investment, production will decline and prices will rise.

**Shifting of Particular Taxes.** Some specific applications of the general theory of tax shifting may be made in the case of certain important types of tax.

*Property Tax.* It is necessary to distinguish between real and personal property. Real property includes land and the permanent improvements thereon, such as buildings. Personal property includes movables, both tangible and intangible. The usual practice in administering the property tax is to make separate assessments of real and personal property, and also to list and value separately lands and structures.

According to orthodox theory, that part of the property tax which falls on the land is not shifted. It is assumed that the landlord is already getting a rent equal to the full economic value of the site and any effort on his part to increase the ground rent would depress the tenant's return to a point at which he would be forced to abandon his lease by recourse to bankruptcy if by no other means. The particular site would then be unused. On this assumption, any tax levied must come out of the owner's return. The tenant cannot afford to pay more.

The case of buildings is different because in the long run investment can be diverted from this field if the return is inadequate. But, because of the long life span of most structures, the ability of owners to shift tax currently depends on the demand and supply situation. Where housing demand exceeds supply, and assuming that there are no rent controls, owners can obtain rents that will provide adequate, even an excessive return on the investment, plus taxes. Where housing supply exceeds demand, as in a declining mill or mining town, owners must make concessions to get tenants, and there can be no question about who bears the burden of the tax.

*Income Tax.* The tax on individual incomes is very likely to stay where it is levied, for the reason that there is little opportunity for subsequent economic transactions by which the tax can be passed on. Stockholders cannot compel corporations to pay larger dividends because of the income tax, and bondholders cannot change the terms of bond contracts merely because they must pay a tax. Again, it must be pointed out that, in the final analysis, stocks and bonds will not find a market unless the income return, after taxes, appears adequate. But, on a year-by-year basis, there is not much

that investors can do about recovering income taxes on dividends and interest. Substantially the same conclusion applies to wage and salary incomes, which are ordinarily determined by the ability and productiveness of the employees. Tightly organized labor groups are able to force wage concessions almost at will, but their demands are not timed with, nor are they necessarily related in any other manner to, tax changes.

With respect to business income, it should be pointed out that a tax on profits or net income has no impact except on the firms that are making money inside the price margin, and that such a tax can therefore have no effect upon the total volume of production at a given time. While there may be exceptions as to particular leaders in specific industries, the general conclusion would be that a tax on business income is not shifted, except as this result would follow from the long-run operation of changes in the flow of capital into industry.

*Sales Taxes.* The general practice under sales tax laws in the United States is to require the seller to bill the tax to the customer as a charge which is separate and distinct from the price of the article bought. This rule has been devised to prevent any unfair advantage from being gained by merchants who sought customers by advertising that they were absorbing the tax when, in fact, such might not be the case. In view of the established tax billing procedure, there is a good *prima facie* case that the customers are bearing the burden. Numerous exceptions probably exist, however, since every merchant is free to adopt a pricing policy that he deems will best further his own interests.

## TAX CAPITALIZATION

The capitalization of a tax is a corollary of the well-known principle of determining capital value by the process of capitalizing the annual income of an asset at some assumed rate of interest. Since the tax constitutes a deduction from the annual income, its effect on the capital value can be ascertained by a parallel capitalization.

Capitalization of taxes can be illustrated as follows, disregarding various technical qualifications: If the going rate of interest on long-term well-secured bonds is 3 per cent, a bond bearing a coupon rate of 3 per cent will sell at par. The income return from a $1,000 bond will be $30 a year, which will be 3 per cent on the investment. If a tax of 1 per cent of the value is imposed on such a bond, the levy, amounting to $10 a year, will reduce the income from the bond to $20. If the owner of the bond offered it for sale after the imposition of the tax, and if the prospective buyer wanted a 3 per cent return on his investment, he would obviously pay only that sum on which $20 would represent a return of 3 per cent, namely $666.66. He would get the same result by capitalizing the $10 tax at 3 per cent, which would be $333.33, and deducting this from the former price of $1,000.

This simplified illustration assumes that there will be an income in perpetuity, and since the bond has a stated maturity date, its price would not decline by the full amount of the capitalized tax. Moreover, it would be necessary for the purchaser to have other investment opportunities not subject to this kind of tax. If every field of investment available to him were subject to a tax of the amount assumed in this instance, he might as well buy bonds as anything else. If other investment opportunities were available in which the tax were less, there would be a capitalization only of the smaller tax. For example, if one state should tax bonds at 1 per cent of the value, while other states exempted bonds as such but levied a tax of, say, 5 per cent on incomes, a purchaser in the income tax states could afford to buy the 3 per cent bond at a price that represented capitalization of the tax of $1.50 on the income.

Tax capitalization is therefore a process by which the burden of a future series of tax payments is placed on the present owner of an income-producing asset. The preceding discussion has indicated two essential conditions for capitalizing a tax. They are: (1) the tax must be unequal or exclusive, since, if it applies generally and leaves no alternative areas of investment at more favorable tax terms, there is no advantage to capitalize; (2) the commodity taxed must have a prospect of fairly long-term income value from which a capital value can be determined. Land and long-term securities fulfill the latter requirement. Durable goods, such as machinery, have a certain period of useful life, but their value will be influenced by the cost of production as well as by the net return they are expected to produce. Consequently, that value is not determinable solely by reference to income.

## ADMINISTRATIVE PROCEDURE OF TAXATION

There are certain definite steps or processes, occurring in a regular sequence, in the imposition and collection of any tax. The taking of private wealth for public use is always a serious matter, to be done according to rules of procedure that have been developed to protect both the taxpayer and the revenue. In some cases the administrative steps are clearly distinguishable; in others they have been telescoped together. The several stages are given below in their usual sequence.

**Determination of Tax Base.** The tax base refers to the objects or classes of objects to be taxed. It may be income, or a class or classes of property, or a single commodity such as tobacco, or certain kinds of imported goods. The tax base is always determined by the law which provides for the tax.

**Assessment.** An assessment is a determination of the size or amount of the tax base. The procedure of assessment will depend upon the character of the tax. Real property, for example, is taxed according to its value. The assessment of real property is the determination of the taxable value of the several parcels of property. Whisky is taxed by the gallon, and assessment means measuring the number of gallons. The income tax payer makes his own assessment in filling out the income tax form, in which he computes the amount of his taxable income. Self-assessment is relatively rare. Ordinarily, it is done by elected or appointed officials.

**Levy.** The tax levy is the formal order for the payment of a tax on the base as assessed, at a specified rate or rates. The levy is contained in the law in some cases, such as the tax on incomes, on gasoline, and on inheritances. Levy of property tax is authorized by law, but it is actually made by the local governing body after the tax requirement is determined in the local budget.

**Determination of Tax Due.** Determining the tax due is essentially a clerical matter. It involves multiplication of the taxable base by the rate or rates of tax to be imposed. It is done by the taxpayer for the income tax, and by clerks in the office of the tax collector in most other cases.

**Review.** Because of the many points at which human judgment and discretion enter into the taxing process, it is always necessary to provide for a review of decisions. The human factor is particularly significant in income and estate taxes at the federal level and in property and income taxes at the state level. The review may be made by an administrative body or by the courts. Factual issues are likely to be better handled by administrative review than by judicial process, but legal issues are always taken into the courts.

**Collection.** All of the preceding steps have had, as their combined purpose, the fair determination of the tax liability.

But the tax must be collected if the taxing process is to serve its ultimate objective. Yet, in many cases, less attention has been given to efficient collection than to the other aspects of tax administration. A corollary of collection is the refund of taxes erroneously or illegally collected.

**Penalties.** Any law that does not provide a penalty for noncompliance is likely to go unheeded and tax laws are no exception. There is a wide range of penalties in tax laws from interest on unpaid installments of a tax to heavy fines and prison sentences for willful tax evasion.

## TYPES OF TAXES

**General Grouping.** There is no authentic formal classification of taxes. The following grouping, however, may be used to indicate certain differentiating characteristics: (1) taxes on persons as such, including the poll tax and the individual income tax; (2) taxes on things, including property taxes and commodity or excise taxes; (3) taxes on acts and privileges, including business taxes, sales taxes, inheritance taxes, and various license taxes. Some legal commentators have suggested that the term "excise tax" includes all kinds of taxes except a capitation, or poll tax, and a property tax. This is a way of indicating the scope, and the limitations, of the federal taxing power under the Constitution rather than a descriptive classification. That instrument authorizes federal use of excises, but requires apportionment of a direct federal tax among the states according to population. The Sixteenth Amendment removed this limitation as to the income tax, thereby leaving the poll tax and the property tax as the only kinds of taxation not unrestrictedly available to the Federal Government under the broad definition of an excise.

**Income Tax.** The idea of taxing income is very old. The tithe of Biblical times was a percentage of the increase of flocks and herds, and this increase was about the only measure of income in a pastoral economy. It was noted above that income taxes were known in Egypt under Roman rule; they were also familiar to the Romans at home. All kinds of taxation fell into relative disuse with the passing of Roman civilization and the rise of feudal-paternalistic states. Some of the early English levies, notably the "fifteenth" and the "tenth," had characteristics of an income tax, although they were nominally levied on assets.

Twice during the long period of the Napoleonic wars England made use of an income tax. On each occasion it was repealed with the passing of the immediate emergency, amid general rejoicing. The third enactment, in 1846, was the foundation of the present English tax. A few of the American states had experimented with taxes on income during the nineteenth century, and during and after the Civil War a levy on income had some years of tenure as a federal tax. In 1891 Prussia introduced a system of graduated rates which was then regarded as a model. The English income tax was levied at a proportional rate until 1907, when a graduated super tax was introduced. France did not adopt the modern type of graduated income tax until 1917.

In the United States, a federal income tax was enacted in 1894, but it was thrown out by the Supreme Court on the ground that a tax on the income from land was the same as a tax on land and hence a direct tax, subject to the apportionment rule. A parallel case decided at the same time held that a tax on the interest of municipal bonds was the same as a tax on the bonds, and hence a federal tax on an instrumentality of state government. It therefore contravened a principle of federalism pointed out by Chief Justice John Marshall, to the effect that neither government in a federal union should tax the agencies and instrumentalities of the other. The Sixteenth Amendment, effective as of Mar. 1, 1913, authorized the taxation of incomes without regard to an apportionment according to population.

*General Income Tax Problems.* One of the most important problems of income taxation that affects all taxpayers, individual and corporate, is the determination of income. This is particularly the case with respect to business income. It is frequently assumed that income is something which can be ascertained with final accuracy, like the answer to a problem in arithmetic. Such, however, is not the case. Business income, for any one year, is at best a reasonably close approximation, not an absolute finding of fact. The reason is that at many points it is necessary to rely upon judgments, estimates, and opinions. This is true because, as a whole, business operation is seldom, if ever, completely concluded at the time an income tax return must be filed. Business firms make an annual cut-off for the purpose of accounting to stockholders, and also for tax reporting. But it is not possible, except in the simplest sort of business, to fix precisely the profit or loss outcome of a large series of operations, some of which may extend into the report year from a previous year, while others, having been started in the report year, may extend into a future year. In addition to these large areas of judgment, there is the determination of depreciation, the valuation of inventories, the proper amount to be added to bad debt reserves and various other matters that involve judgment or opinion. The objective of business accounting is to arrive at as nearly correct an approximation of the results of operation as possible. Every accountant knows that it is, after all, only an approximation which will be revised and improved in the light of subsequent developments.

The point of emphasis is that the results of business accounting, assuming that some adequate system of accounting is consistently followed, should be given great weight in arriving at taxable income. This is particularly worthy of note in the case of some of the important charges and deductions against gross income which business regularly makes. Some examples are given in the following discussion.

Depreciation. The purpose of depreciation accounting is to provide, out of income, for the recovery of the investment in tangible, fixed assets while they are still in use. The value of these assets disappears, first, through wear and tear in use, and second, through obsolescence. As the tools and other equipment used in production are worn out, or become obsolete, the expenditure for their original acquisition must be recovered; otherwise the firm will eventually find itself in a position where it cannot continue operation. It will, in fact, have used up its capital. Proper charges for depreciation and obsolescence are as much a part of the cost of production as are the payments for labor and materials. The principal difficulty encountered under the income tax is the determination of what constitutes proper charges for these purposes.

Business Net Losses. In view of what has been said about the results of business operation being, in a substantial degree, determinable by reference to judgments and opinions, it follows that the fact, and the amount, of a loss for a given year is an approximation similar to that which would indicate a profit. Subsequent developments may lead to a correction, as illustrated by the later discovery that the allowance for bad debts is greater than actually required.

There is general agreement among accountants and tax experts that business losses should be offset against the business profits of other years before a net profit or net income can be shown on which a tax may be levied. In actual operation, a business must absorb or offset its losses against its

profits; otherwise, if all profits were distributed, without regard to losses, the capital would in time be dissipated, since the loss outgo means a payment of part of the business expense out of capital funds.

Income tax laws ordinarily permit an adjustment of net business losses against net profits. This adjustment can be made by carrying the loss backward in time and revising the profit statements of earlier years, or it can be carried forward as an offset against the profits of future years.

Capital Gains. A capital gain is a gain which is realized from the sale or exchange of a capital asset. The Supreme Court of the United States held long ago that such gains are income. The income tax law, since 1921 at least, has provided a separate method of taxing capital gains if the capital asset has been held longer than a period stated in the law. Short-term gains, that is, gains from sale or exchange of capital assets held for a period shorter than that specified, are taxed in full along with other income. Capital gains and losses may be offset against each other, and net capital losses may be carried forward. But the amount of such loss that may be deducted from other income is limited to the loss itself, or to $1,000, whichever is smaller.

The principal theoretical issue is whether or not a capital gain is really income, despite the Supreme Court's opinion. For the most part, such gains are not regarded as income in England. Capital assets are defined in such a way that the principal class of such assets consists of stocks and bonds. They would also include commodities traded in on the produce exchanges, and property generally which is not accounted for in inventories or which is not subject to ordinary depreciation accounting.

*Individual Income Tax.* There are certain matters which are of particular significance in the taxation of individual incomes. Some of these follow.

Concept of Individual Net Income. Income, as such, is not defined by the Sixteenth Amendment. The tax is levied on taxable net income, which means the total of certain specified types of receipts, less certain specified types of deductions. The deductions allowed from gross income are of two classes. The first includes designated kinds of costs of gaining the income, such as wages, costs of materials, maintenance of property used in getting the income, depreciation, interest, taxes other than the income tax itself, losses not covered by insurance, bad debts, and similar costs of a business nature, and also a limited amount of charitable contributions. Deduction of these allowable items from gross income results in net income. The second class of deductions consists of the personal exemptions and dependency credits allowed to the taxpayer. The amount remaining after taking out the second group of deductions is net taxable income.

Net income is a business concept and it has only an artificial meaning when applied to the individual. The latter may deduct certain types of expense that are identifiable as business expense, such as wages paid, depreciation on property used, costs of materials and supplies, fuel, and other maintenance costs related to property used in gaining income. But these items are appropriate only for individuals deriving income from business operations. The person whose income is derived as wages or salary for personal services has little benefit from them, yet he obviously has his own costs of gaining income which are analogous to those involved in getting business income. Many of these costs to the worker are grouped under the head of family or living expenses and are not deductible.

Personal Exemptions. A great deal of confusion about the personal allowances to the taxpayer and his dependents is typical of general tax problems from year to year. This kind of credit was first introduced under the early English income tax and there was a great deal of debate over the propriety of providing an amount of income, free of tax, which was supposed to represent the cost of subsistence. It has always been at or near a bare subsistence minimum in the English law. Because of this precedent, exemptions were incorporated into the United States law. There has never been a pretense, however, that the amount allowed was in any way related to subsistence cost. Rather, the allowance has been determined mainly by fiscal expediency. The first federal income tax act, passed in 1913, provided an exemption of $4,000 for a married couple and $3,000 for single persons. The credit for dependents was $200 in the act of 1916 as against $600 in 1948. The exemptions were lowered during World War I and raised again during the 1920's, and again lowered during World War II. The act of 1948 set the amount at $600 for the taxpayer and $600 for each of his dependents.

It is obvious that the number of taxpayers subject to income tax will be directly affected by the exemption level because of the distribution of incomes among the lower income groups.

Rates of Individual Tax. There is no principle by which the proper rates to be imposed on individual incomes can be determined. The practice of taxing such incomes at progressive rates is almost universal. Proponents of a system of moderate rates, as opposed to extreme progression, have argued that excessive rates have a destructive effect on savings and investment, on the readiness to assume risks, and on the enterprise incentives. They have held that as much or even more revenue would be obtained from a system of moderate rates as from a system of excessive rates. The concept of moderation is itself relative. Under the Revenue Act of 1928 the maximum rate of federal tax was 25 per cent, applicable to surtax net income of $100,000 and more. During 1947 and 1948 a goal of 50 per cent as the maximum rate on income of $100,000 and more proved politically impossible of attainment. As the war tax rates stood until changed by the act of 1948, there was a rate of 50 per cent or more on all taxable income above $18,000. Under the act of 1948, the 50 per cent level was reached at $32,000 of taxable income.

Tax Withholding. The payment of a part of the tax at source, by deductions from payments for personal services (wages, salaries, commissions, and other similar payments) is a necessary procedure while there are many millions of small income earners subject to income tax. It is, in fact, considered the only feasible method of collecting the tax, for the administrative expense of securing personal returns from so large a group would absorb all that was collected. Persons with wage or salary incomes up to $5,000 and with no more than $100 of other income can pay their entire tax by the withholding method.

Declaration of Estimated Tax. Every person who anticipates an income of more than $5,000 must execute a declaration of estimated tax for the year. This declaration is to be filed by March 15, accompanied by payment of at least one-fourth of the estimated tax due, taking into account the tax, if any, to be withheld during the year. This is a valuable feature of the income tax procedure. It puts the payment of income tax on a current basis, that is, payment out of income as received. Prior to its adoption in 1943, there was a lag of one year between the receipt of income and the payment of tax thereon. This became acutely embarrassing for many when retroactive increases of tax rates were

made, or when current income unexpectedly fell below the prior year's income.

Tax Treatment of Dividend Income. In legal theory, a corporation is an entity separate and distinct from the group of stockholders. It is a legal person. Its assets, debts, and income are distinct from those of its stockholders. Yet the body of stockholders together own the corporation, and they are the beneficiaries of any distributable income it may earn.

*Corporation Income Tax.* All income inures eventually to the benefit of individuals. From this general proposition it is possible to deduce that all income should be taxed to individuals and that business, as such, should not be levied upon. Some of the difficulties of such a course were noted above. The fact is that there will probably always be taxation of business, with or without some kind of recognition of the burden by credits or allowances to individuals.

An interesting and important question is that of the relative effect of a tax on corporation income, as compared with a tax on individual income, from the standpoint of investment incentive. Some would exempt, or reduce greatly, the corporation tax and make up the revenue loss by increasing individual taxes; others would do the opposite by keeping fairly high taxes on corporation income in order to lower individual tax rates. The process of saving and investment is motivated principally by the prospect of return commensurate with the risk. If this return is inadequate, investment will diminish. It makes little difference whether the inadequacy is caused by heavy taxes on the corporation's income or on the individual investor's income.

Retained Earnings. The United States income tax law has long contained a provision imposing a special tax on earnings deemed to have been improperly retained in order to benefit large stockholders. The purpose of the special, or penalty, tax is to force distribution of all, or a large part, of the income to stockholders where it would be subject to the heavy rates of the individual tax. The fact that dividends do not account for a substantial portion of the corporation's income is usually deemed to be evidence of an intent to shield stockholders.

Intercorporate Dividends. If one corporation owns stocks issued by other corporations, it naturally receives dividends thereon as paid. Since the distributing corporations have already been taxed on their respective incomes before paying dividends, it is logical to exclude such dividends from the taxable income of the recipient corporation to avoid double taxation. In 1948 the federal law permitted deduction of only 85 per cent of dividends received, thereby taxing doubly the other 15 per cent.

Consolidated Returns. Corporations which are members of a closely affiliated group of companies ordinarily make a consolidated return for the information of their stockholders. In 1948 the federal law permitted this kind of return for tax purposes, but imposed an additional tax of 2 per cent on the income shown in such a return.

**Excess-Profits Taxes.** In World War I and again in World War II, the United States government taxed so-called "excess profits." The vast destruction of modern war means a great expansion of production, particularly in the lines of goods required for the war effort. Modern wars have been financed in part by methods that are inflationary, and the inflation leads to greater volume of business even among the businesses that are not directly engaged in war production. Greater volume results, for a time at least, in larger aggregate profits. Hence the demand that some kind of special tax be imposed on these profits.

The measurement of excess profits can never be exact in an absolute sense. The tax laws, therefore, have fallen back upon arbitrary standards for this purpose. In the excess-profits tax in force during World War II, alternative standards of excess profit measurement were provided. One was an earnings base, being 95 per cent of the average earnings of the base period from 1936 to 1939, inclusive. The other was an invested capital base, on which excess profit was determined to be the amount of profit above stated percentages of the invested capital. Each corporation was permitted to choose between these methods.

**Poll Taxes.** The other method of taxing persons as such is by a poll, or head, tax. This tax was used by the ancients to emphasize inferiority of political status. It was used by the American Colonies, and was an important cause of Bacon's Rebellion in Virginia in 1676. Yet, almost a century after that episode, it was still the most productive of all the Virginia taxes. The poll tax has often been criticized because of its use in some states as a prerequisite to voting. Yet it is levied directly under the constitutions, or required by constitutional provisions, in twelve states, and it is permissive in all other states except Maryland, Oregon, Ohio, and Utah, whose constitutions forbid such a tax. The Maryland constitution says that a poll tax is "grievous and oppressive." The receipts are usually devoted to schools, or to roads and streets. In Connecticut, it is used for old-age assistance. Vermont applies part of the yield to this purpose, and in North Carolina a part is used for support of the poor. The revenue aspect of the poll tax depends upon the wealth and income of the state. In some states it produces more than the inheritance tax, even when administered indifferently.

**Property Taxes.** The property tax is one that is levied on all forms of property, or on designated classes of property, according to value. This tax was once an important source of revenue for the states and their local subdivisions. It has since been relinquished very generally to local units of government because the states have developed other forms of taxation. In 1915, for example, property taxes comprised 50 per cent of total state tax revenues. By 1942 these taxes supplied only 5.4 per cent of state tax receipts.

The theory of a property tax is that the value of property owned is a fair measure of the tax which the owner should pay. This theory was reasonably correct under primitive economic conditions, such as existed in the American Colonies and in the early part of the nineteenth century. Land was then abundant and cheap, and it was available somewhere to all but the thriftless and the lazy. The other wealth of the community consisted mainly of buildings, livestock, simple tools and machines, and merchandise. There were few assets other than visible property by which to measure wealth and income. The growth of the modern business economy, with a banking and credit system and business corporations having a wide array of securities, meant the rise of forms of wealth that were not openly visible. Moreover, the increasing specialization of labor led to the rise of numerous classes of professional workers who obtained income through services rather than from the ownership and use of property. Such groups would pay no taxes directly in a community that relied solely upon the property tax, and the invisibility of the rights and titles represented by stocks, bonds, mortgages, and bank credits presented an insurmountable problem of assessment. Many states have abandoned the attempt to assess and tax so-called intangible property because of these assessment difficulties. In those states the property tax is limited to real estate, namely, lands and buildings, and in some other cases to certain forms of tangible personal property such as livestock, machinery, and merchandise.

*Assessment Systems.* The principal practical problem presented by the property tax is that of valuation, or assessment. The historic rule has been that each parcel or item of property shall be assessed at the value it would command in a free market transfer. Again, this rule was reasonably valid in a primitive society in which property units were small and trading in them was both general and active. Under such conditions the property assessor had at hand a ready standard of reference by which to judge reasonably well as to what a farm, a house and lot, a horse, or a cow would be worth in the market, even if the particular item of property had not been offered for sale. This rule of fair market value ceases to be applicable with the rise of large property aggregates such as railroads, rolling mills, office buildings, and the like. There is no market in which these kinds of property units are bought and sold on a scale that would provide a guide to fair market value. Complicated assessment systems have, perforce, been developed to deal with modern assessment problems, but there are few places in which recognition has been given to the fundamental fact that some other method of taxation is required for the classes of property for which the market no longer provides an adequate valuation guide. In England property is taxed on the annual income value rather than on the market or capital value.

*Effectiveness in Localities.* The property tax, particularly on real property, is a natural source of local revenue because this is the one form of property that cannot be concealed or removed from the jurisdiction. It is for this reason that the property tax has been so largely relegated to local use. With the expansion of local expenditures there has been a tendency in some cities to overload this tax. The consequences of such a policy are particularly disastrous under depression conditions, since there is no enforcement procedure competent to deal with wholesale property tax delinquency such as was experienced in many places during the early 1930's. Broadening of the local revenue base has been enforced by a number of states by imposing limitations upon the maximum rate of levy, but the protection thus afforded against excessive taxation is only partial unless there is also effective administrative or judicial control of the assessment procedure.

**Taxes on Commodities.** The taxes on selected classes of goods are, in one respect, a kind of tax on property. They may even be assessed, as is the property tax, according to the value. Another method of determining the taxable base is by levying the tax on some specific quantitative unit, such as the pound, yard, or gallon. There is, however, an important procedural difference. All property is assessed as of a given date, but the commodity taxes are imposed at the time of sale, or at the time of removal from storage in bonded warehouses. The general classes of commodity taxes include those on imported goods, which are called customs duties, and those on certain articles of domestic production, which are called excises.

*Restrictions on States.* The Federal Government levies both customs and excises. The states are forbidden by the constitution to impose customs duties, but they are entirely free to levy excise taxes. The restriction on state taxation of imported merchandise applies only to taxes laid at the time of importation. After foreign goods have become part of the general stock of goods offered for sale in a state, they may be taxed by it in any manner generally applicable to other goods. For example, a state may not levy an import duty on foreign perfumes, but once these perfumes are offered for sale in a department store, they may be taxed as merchandise under a property tax, a state cosmetics tax, or a state sales tax.

*Customs Duties.* Customs duties are imposed, in theory, for revenue purposes, but in practice they have long been imposed for other reasons, chief of which is to restrict, or even to prohibit, the inflow of foreign products likely to compete with domestic products. The arguments for protective tariffs are essentially political rather than economic and fiscal. As a revenue source, the customs are now relatively unimportant, the yield being only about 1 per cent of total federal revenues of the United States.

*Excises.* The federal excise system has varied with the revenue need, both as to extent and rates. Such taxes were used in the early days of the Republic, and again during the War of 1812. They disappeared again until the Civil War, after which the taxes on liquor and tobacco became permanent. World War I caused a broadening of the system, but many of the war excises were discontinued during the 1920's. There was some expansion of the system during the 1930's and an enormous increase of both rates and coverage during World War II.

Wide difference of opinion exists regarding the proper place of the excises in the federal tax system. At one extreme are those who would abolish all excises except the taxes on liquor and tobacco. At the other extreme are those who would expand the excise tax yield to constitute a substantial proportion of the total federal receipts.

**State Taxes on Commodities.** The states have been driven, by their revenue needs, into the taxation of a considerable list of commodities. All states that adopted the licensing system for the sale of alcoholic beverages after the repeal of the Eighteenth Amendment tax these beverages. Cigarettes are taxed in more than thirty states. Gasoline is taxed in all states. Beyond these important instances, there are scattered cases of state taxes on other commodities, but they are of little importance for the revenue. Liquor, tobacco, and gasoline are also taxed by the federal government. They constitute an important segment of the perennial problem of federal-state fiscal adjustment. Until the federal budget can be reduced there is little likelihood that the federal levy will be discontinued. Relinquishment of the gasoline tax to the states was recommended by the Committee on Postwar Tax Policy in 1945.

**Business Taxes.** Among the various ways of taxing business as such is the method known as the franchise tax. The business franchise includes different kinds of privileges, the number and importance of which depend upon the form of business organization. The corporation charter is a kind of business privilege. The size of the ordinary incorporation fee, usually about $25, indicates that no great value is placed on this particular privilege. Articles of partnership, moreover, may be drawn up and signed without the payment of any fee to the state.

The most important application of the franchise principle in the field of taxation is its use by the states in taxing business. In this sense it is a case of taxing the privilege of doing business within the state, and there can be no question that such a privilege is valuable in view of the authority of any state to exclude a given corporation or other business firm from doing business inside its borders if the state's rules and regulations are not observed. The accepted measure of the value of the franchise to do business within a given state is the net income derived from such business. A tax on the privilege of doing business, measured by the net income, is distinguishable from a tax on the net income.

The principal economic and accounting problem raised by such a tax is that of determining how much net income is realized from the operations within a particular state. If a

given company is operating in several states, and many large companies do more or less business in all states, it becomes important to have a reasonable rule for determining what part of the total income, which is naturally a product of the total operations, is properly taxable in any one state. Business records of receipts and expenses are seldom, if ever, kept on a state-by-state basis. In general, some method of allocation is necessary. Any allocation will be arbitrary, and the particular method used is less important than that there be reasonable uniformity of procedure. The various states have not accepted any one uniform method. The allocation system evolved in Massachusetts has been more generally accepted than any other, and it is generally conceded that it should, therefore, be introduced as the uniform procedure. In brief, its provisions are as follows:

(1) Investment and other nonoperating income is to be allocated within or without the state according to domicile or origin. For example, rents of real property located outside of the state are to be allocated to the state of origin. Income from investment is to be allocated to the state in case of a domestic corporation, and outside in case of a foreign corporation.

(2) Operating income is to be allocated on the basis of the following formula: one-third of the net operating income on the basis of tangible property within and without the state; one-third on the basis of the pay roll inside and outside the state; and one-third on the basis of sales inside and outside the state.

The sum of the fractions of net operating income obtained by application of the above formula constitutes the net income from the business done both within the state and without the state. This formula is considered sound, economically, since the principal components in the production of income are physical property or plant, workers employed, and sales. If such a formula were generally used, each state in which a given corporation did business would get its appropriate aliquot part of the company's total net income, and the several parts would add up to 100 per cent of the net income.

**Sales Taxes.** The sales tax is levied in various states at rates ranging from 1 per cent to 3 per cent. It has become, for the states that use it, one of the most productive of all state sources of revenue. In fact, it has become so embedded in state fiscal programs as to render unlikely any prospect that it will ever be abandoned. The sales tax is very generally imposed as a tax on the privilege of selling at retail. Thus it belongs in the general class of taxes on acts and privileges. The tax on this privilege is measured by an amount equal to a stated percentage of the sales during the year. The basis is net sales, which takes account of refunds, returns of goods, and so on. The dealer is the taxpayer, in that he settles with the tax collector, but virtually every sales-tax law provides that the tax shall be collected from the consumer, who thus becomes the tax bearer. While the incidence of the sales tax is generally on the consumer, there is nothing to prevent dealers from making a price adjustment that involves absorption of the tax.

**The Use Tax.** The complaints of dealers against the exemption accorded sales in interstate commerce led to the use tax, which is a device whereby the interstate commerce exemption might be circumvented. The use tax is a levy on the use, storage, or consumption of goods that would be subject to a sales tax if bought within the state. Thus, in legal theory, it is a tax on every act of use, storage, or consumption, regardless of the origin of the goods. All goods on which a sales tax has been paid are exempt from use tax. The courts have sustained use taxes. They are obviously not completely enforceable because of the impossibility of supervising the interstate transactions of all the citizens. The worst feature of this type of tax is that judicial sanction has been given to the efforts of the collecting state to compel business firms in other states to submit to audits of sales to customers within its borders. Mail-order houses are the principal targets for such extraterritorial audits. The precedent has been viewed by some as potentially dangerous, since it may lead to an extension of one state's authority to persons or businesses outside its jurisdiction of a wholly improper and undesirable sort.

**Motor-Vehicle License Taxes.** With the great growth in the use of motor vehicles, some system of identification became necessary for police control purposes and for the protection of owners. The method universally used is a registration of the vehicle, based upon evidence of ownership. One or two plates, or "tags," must be attached to the vehicle to indicate compliance with the registration requirement. It quickly became apparent that this practice could provide a lucrative source of revenue, and the rates established were set much above the costs of registration. This was considered a proper attitude in view of the strong public demand for highway improvement and in view, also, of the fact that the motor-vehicle revenues were used for road construction and maintenance. Broadly speaking, it was a case of applying the benefit doctrine of taxation.

**Miscellaneous License Taxes.** In the tax laws of the 48 states will be found a long list of occupations, activities, and transactions which are subjected to license taxes. The southern states in particular have traditionally applied a wide variety of such taxes.

**Death Taxes.** The transfer of property from one generation to another is probably as old as the institution of property itself. It may occur either by inheritance, which means succession in the family line, or by bequest, which means a disposition by will or testament. Two types of death tax have developed. One is the inheritance tax, which is based on the amount of property passing to each separate heir; the other is the estate tax, which is levied on the estate before distribution to the heirs.

Tax rate progression is very generally used in both forms of the tax. In the case of the inheritance taxes, there is frequently a dual graduation, one series of rates applying to the specific amounts and another to the degree of relationship of the various heirs to the decedent. There are good arguments in support of each form of death tax. For the inheritance tax it can be said that the tax burden is adjusted to the amount which each heir receives; and to the extent that the bequest indicates some exceptional ability to pay, the amount that each beneficiary receives is the proper measure in his case. But the inheritance tax presents a serious administrative problem, which also involves questions of equity, in the case of a bequest which is divided between a life tenancy and a contingent interest. The person who inherits only a life interest in property should not pay the full tax that is computed. On the other hand, the remainder inheritor has only a future interest which he may not live to enjoy. The apportionment of the tax between the two parties, and the time of collecting the residuary legatee's share, are matters that are extremely difficult of satisfactory solution.

The estate tax avoids this issue because it is collected on the net estate before distribution. But it does not conform with the so-called ability principle as closely as does the inheritance tax, if the estate tax rates are graduated.

Two problems of special importance in connection with

death taxes are: first, the question of domicile; and second, the question of contemplation of death.

The problem of domicile has arisen in the case of the state taxes. For a long time it had been assumed that a person could have only one domicile, one place which he regarded as his home. He might own residences, hunting lodges, or summer camps in other states, and he might divide his time among these various residences, but these facts were not deemed to contradict the basic fact of a single domicile. The matter is important only in the case of a large estate, and in recent years the states have had opportunity to engage in intense rivalry for the opportunity of levying the tax on these estates. As these cases went to the Supreme Court that body produced the doctrine that a person can have more than one domicile, in more than one state. The owners of these large estates, during life, had engaged in some questionable practices with respect to domicile in an effort to escape local income and other taxes, or to take advantage of particular state laws respecting the creation of trusts, and so on. The resulting field day that the states have had in levying multiple inheritance taxes was made possible by the decisions, but it was also a product of the juggling that had gone on before the death of the owners of these fortunes. Double or multiple taxation of estates is highly objectionable. The states had been well on the way to the elimination of this abuse through reciprocal agreements, but the new doctrine of double or multiple domicile has largely undone the results of the years of patient negotiation that had gone into the reciprocity movement.

During the development of the inheritance taxes it was possible to avoid the tax by making distributions of property during life. The gift tax was designed to prevent avoidance of this sort, but there still remains the question of whether or not a gift is made in contemplation of death. If this motive can be proved, the transfer is taxable at estate tax rates rather than at gift tax rates, which are, in the federal law, only three-fourths as high throughout the rate scale. One solution has been to provide that if death occurred within a stated period after the gift was made, it constituted prima facie evidence of being a transfer in contemplation of death. But death comes at all ages. A person in middle life, in good health, may die suddenly. It is hardly tenable to hold that such a person had in mind his early demise in making gifts of property to his wife or children. On the other hand, proof that he did not is hard to obtain, especially after his death.

Aside from this issue, for which there is no easy solution, there is the question of what constitutes a gift. The question does not arise in the case of complete, outright, irrevocable gifts or transfers, but rather in the case of trusts which involve reservations of one sort or another. Settlers of trusts have sought in various ways to reserve powers, or to grant powers, with respect to the property conveyed, and many of them have encountered difficulties because their reservations were such that a clean-cut, outright gift was not made.

### EFFECTS OF TAXATION

**Burden on Taxpayer.** The principal effect of taxation, one which should never be lost from sight, is that it is a burden on the taxpayers. Since there must be government, it follows that there must be taxes. Notwithstanding that the services of government are, to a certain level of cost, advantageous to society in general and to the profitable conduct of business in particular, it is still true that the taxes levied to defray this cost are a burden on those who must pay them. They have less of the fruits of their own labor after the taxes. Government spending and taxing mean that the decisions with respect to the application of a portion of private income are made by others. As taxes increase, the share of the taxpayer's income over which he has no control rises.

H. L. L.

**TAXIDERMY.** The art of preserving skins and mounting them in lifelike positions. The word is taken from the Greek *taxis,* meaning order, and *derma,* the skin.

When it was that man first became interested in the preservation of animal specimens in a more or less lifelike state we cannot say, but there are a few brief accounts here and there that give us a suggestion that the art of taxidermy may have been carried on from quite remote times. A story of Hanno, the Carthaginean navigator, for example, describes the discovery and capture of what were probably gorillas five hundred years before the Christian Era and states that the animals were killed and their skins taken to Carthage. Pliny tells us that these skins remained in the temple of Astarte until the year 146 B.C.

When the Egyptian tombs, of an even earlier period, were opened, many embalmed specimens of cats, dogs, monkeys, ibises, and other animals as well as humans were found. But this art of embalming, as the Egyptians knew it, was invented to satisfy their religious beliefs and cannot come under the heading of taxidermy, for taxidermy proper attempts to reproduce specimens that are both true to nature and look alive. The Egyptian specimens were merely preserved bodies.

The first inkling we have of an attempt at mounting birds was in Amsterdam early in the sixteenth century; here the skins were arranged on a system of wires and filled with spices to preserve them. Late in the same century we find mention of taxidermy in Shakespeare's *Romeo and Juliet* (V,1):

> I do remember an apothecary,
> And hereabouts a' dwells, which late I noted
> In tatter'd weeds, with overwhelming brows,
> Culling of simples; meagre were his looks;
> Sharp misery had worn him to the bones:
> And in his needy shop a tortoise hung,
> An alligator stuff'd and other skins,
> Of ill-shap'd fishes.

The first publication on the art of taxidermy was written in France in the year 1687, and a German writing issued at Leipsic in 1778 gives a description of methods used at that time. H. T. Race of Denmark published a book in 1842, and there was one by Nathaniel Whitlock of London 1831. Though the earliest publication of this kind to appear in the United States was in 1865, taxidermy work of the highest standards of any in the world has been produced here.

Early methods used in the art were crude indeed. The skin was taken off the animal by means of an incision along the stomach. It was then pickled in a solution usually made of salt and alum in water. After about one week in this, the skin was rinsed in water and the hair dried in warm sand or sawdust. The legs, head, and tail were then wired and these wires were twisted together inside the body cavity. A soft filling such as straw, grass, and, more recently, wood wool was used to stuff the skin. The incision was then sewed together and the animal was placed upon its feet and fastened by the protruding wires or rods.

From these crude beginnings have evolved modern methods of taxidermy. By these methods the taxidermy artist can reproduce an animal that lacks nothing save motion, as far as the eye is concerned. The preserved skin is fitted and glued fast to a plastic form that has been modeled to look

exactly as the original animal's body would be if the skin were removed. The tense muscles, tendons, and surface veins are beautifully reproduced. From this description one can readily see why it is no longer correct to speak of a "stuffed" animal; modern taxidermists "mount" the animal's skin. The art is so highly specialized that the mere knowledge of methods no longer spells success; it is also essential to have an intimate knowledge of the anatomy and habits of living animals.

Following is a brief description of methods used in preparing the different forms of animal life.

**Birds.** As soon as possible after the specimen is killed the blood is washed off the feathers. Shot holes, mouth, and nostrils are filled with absorbent cotten. Water-color notes are taken of the nonfeathered parts, such as the eyes, beak, feet, and wattles if any, and notes are made of the bird's sex and of the locality and date the specimen was killed. Unless one has a series of measurements, the total length and length of wing should be recorded.

After these preliminary notes have been taken, the actual work on the specimen begins. The feathers on the breast are parted and an incision is made from the center of the breast bone to the vent. The skin is now peeled from the body on each side of the incision until the knee joint is exposed. Powdered borax is sprinkled on the flesh to keep the feathers clean and the fingers dry. After the legs have been severed at the knee joint, the skin around the tail area is carefully loosened and the vertebra which holds the tail is severed, care being taken not to cut the tail feather quills. Next the skin is turned down over the back until the wing joints are reached, borax being sprinkled whenever necessary. The wings are cut free near the body and the skin is turned further wrong side out down over the neck and on over the skull until the ears are reached. Here the skin is cut close to the skull or pulled out of the ear socket. When the eyes are reached, a cut is made through the thin, bluish membrane, care being taken not to cut the eyelid. The skin is then gradually peeled forward over the skull until the base of the beak is reached. The skull is left attached here, and the neck is cut loose from the skull. Birds with large heads will have an extra incision made on the back of the head in order to skin out this part, since the skull is too large to allow the neck skin to be turned over it in the usual way. Ducks, woodpeckers, and a few other birds will require this treatment. Next the eyes are removed and a deep cut is made into the roof of the mouth and back to the base of the skull. This piece is detached and the brain is removed through the opening. The remaining flesh is now cleaned from the skull, and the skull, head, and neck skin are painted with arsenic solution; the eye sockets are filled with cotton, and the head skin is then turned back over the skull, beginning at the base of the beak. To smooth the feathers on the head a blunt instrument like a knitting needle is used; this is passed through the eye opening and moved carefully back and forth under the skin.

In the next step, the wing skin is turned down over the first joint and the flesh removed. The legs are turned down to the heel or, in most birds, where the feathers stop. The muscles are then cleaned off, leaving the bones intact. This part of the leg skin is painted with arsenic solution and the leg bone is pulled back into the skin; the bottoms of the feet are now opened and the large tendons are pulled from the legs. The tail area is cleaned next, care being taken to remove the oil sacs above the tail. All fat and flesh are now cleaned from the skin, borax being used to absorb any free oil. The under side of both wings is opened, all flesh is removed, and the skin is painted well with arsenic solution. This incision will not have to be sewed up if the bird is to be mounted with closed wings. Finally, the rest of the inside of the skin is similarly poisoned.

As a base for mounting the skin, a body is carved out of balsa wood, using the natural body for a guide. A sharpened wire is run through where the neck joins the body and a neck of cotton is constructed, thread being used to wind it. The wings are wired by running sharpened wires from the inside of the skin all the way to the tip of the wing bones. About one half inch of the end of the wire is turned up at right angles and forced through the wing bone, coming through on the outside of the wing. The wire is tied to the bone in several places. The legs are treated in the same way by running the sharpened wire through the sole of the foot and continuing up the back of the bone. The wire is tied as before and the muscles replaced with cotton and thread. Now the neck wire is inserted through the opening in the skin, and the artificial neck is run all the way to the base of the skull, the protruding neck wire coming out the mouth. The wings and legs are fastened in their proper positions by running the wires through the body and turning them back on themselves in the form of a staple and forcing them back into the balsa body, using the natural body as a guide. Next a wire is run through the base of the tail and fastened to the body in its proper place. The incision is sewed up, and the wings, legs, and head are bent into their natural positions. The bird is then set on a perch, the protruding leg wires being used to fasten it by running them through holes drilled in the perch.

Wherever necessary, the skin is arranged with a pair of tweezers and the posture of the bird is corrected. The feather tracts are arranged in their proper places. Now, artificial glass eyes are inserted, a small portion of papier-maché being used in the sockets, and the lids are arranged around them. The tail is fastened between two pieces of cardboard with pins, and thread is wound carefully around the bird to keep the plumage smooth until the skin is dry, which will take about two weeks. When the skin is dry, the thread and all protruding wires are cut off and the cardboard is removed from the tail. Finally, the colors are restored to the beak, legs, and other faded parts by means of the sparing use of oil paints.

**Mammals.** Detailed measurements are first taken of any mammal that is to be mounted. Plaster-of-Paris casts are made of the face and of any other parts that the preparator thinks necessary. These are made both before the skin is removed and after. The opening cuts are then made, the first being made in a straight line from a point between the front legs back along the stomach to the vent and on out to the tip of the tail. Another cut is made on each leg, beginning at the hoof or foot and continuing up the back of the leg to meet the stomach incision at right angles. If the animal has horns, an additional cut must be made on the back of the neck continuing to a point about three inches back of the horns. From here an additional incision is made to each horn. The skin is removed completely if the animal is large.

Small animals are treated a little differently. One incision is made on the stomach, as in birds, and the tail is stripped from its sheath from the inside. The leg bones are left attached to the skin at the feet and are cleaned of flesh. After the skin is scraped clean of all fat and flesh it is washed in soap chips dissolved in water and then rinsed in water, degreased in benzene and alcohol, and dried in sawdust. It is then mothproofed with arsenic solution. The mounting operation is very similar to that of birds. An artificial body is

made. The legs are wired, and the muscles are built on with excelsior or carved in balsa wood. The body is inserted, and the legs and tail are fastened in their proper places. The incision is sewed up, the animal is placed on its base, artificial eyes are set in place, and the mouth and nose are shaped with papier-maché.

The large animal skin must be spread out flat, thoroughly salted, and rolled up over night. It is then placed over a beam and scraped free of flesh and fat. The ears, eyes, lips, and nostrils must be split on the inside, the cartilage removed, and the skin well salted again and allowed to dry in the shade. The skin is then put through the tawing process to make it soft and pliable.

There are two processes by which skins are prepared for mounting purposes. One is the tanning method, by which skins are actually turned into leather by the use of a pickle made from the barks of certain trees and from plants that contain tannic acid. Skins of the elephant, rhinoceros, and hippopotamus are prepared for mounting by using this pickle. The skins, which are very thick, must be shaved down with special knives to an even thickness of one-quarter inch. An elephant skin is three fourths of an inch to an inch in thickness when removed from the animal; this must be shaved down soon and is a herculean task in itself. When shaved, the skin is placed in the pickle bath. These heavy skins must remain in the solution until the pickle penetrates all the way through, which takes several months. When this process is complete, the skin is washed in water, oiled, and placed in large revolving drums containing hard-wood sawdust; several oilings may be required before the task is completed. When finished, the leather resembles that which is used in the making of shoes.

The second process is called tawing and is used on all skins that are covered with hair or fur. Salt and alum are mixed with water, and after the skin has been shaved down to an even thickness as before, it is immersed in the pickle

*Typical preparation of large bird (restoration of extinct moa by Georgt Adams, Chief Taxidermist, American Museum of Natural History): (upper left) armature set up and barreled out with wire netting; (upper right) netting covered with squares of burlap dipped in wet plaster; (lower left) anatomical details carefully modeled in clay (lower right) completed specimen, with original skin fitted over*

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and left there from one to two weeks, depending on the kind of skin. The purpose of the pickle is to break down the glue in the skin and leave the fibers free for softening. When the skin is removed from the pickle bath, it is washed in water and hung up to drain and dry a little. Beaver oil, a type of oil used for tanning purposes, is then brushed on the flesh side of the skin. The hide is placed in the drum as before and revolved until the oil is kneaded into the fibers. This process also cleans the hair, and any surplus oil that is on the skin is absorbed by the sawdust.

While the tanning is being done, an armature is set up which is a rough outline of the animal that is to be mounted. A pipe or wood upright is firmly fastened to the center of the base on which the animal model is to stand. To the top of this upright, which will be slightly higher than the back of the animal, is bolted a center board cut roughly to the shape of the animal's body. If the animal's anatomy is not well known, the cleaned skeleton must be wired on this board and the leg bones fastened in their correct places on the skeleton, using soft iron rods bound to the leg bones and fastened securely both at the top and on the base. If the taxidermist is thoroughly familiar with the animal's anatomy, the body skeleton can be left out and only the leg bones and skull used, fastening them to the center board with the iron rods. Black iron wire netting is used to cover this, barreling out the body to roughly the shape and size of the animal, using the measurements and the skeleton as a guide. Over this are laid burlap squares that have been dipped in liquid plaster of Paris. When this is dry, it forms a strong support over which the figure of the animal is modeled in clay. Every surface muscle, tendon, and vein that will show is carefully worked out. A plaster of Paris piece mold is then made of the clay model, and a light reproduction of the clay figure is made in this mold, using wet building paper that has been torn in strips two or three inches wide and coated with paste. Layer upon layer of pasted paper is pressed into the mold until the proper thickness, depending on the size of the animal, is built up. When this is dry, the halves are fastened together. Iron rods that have threads on their bottom ends are bent to the shape of the legs and fastened inside, leaving the threaded ends protruding from the bottoms of the feet. When thoroughly dry, this form will be very light and strong. One nut is put on each of the four leg rods, and the ends of the rods are run through holes that have been drilled in the base on which the animal is to be mounted; another nut is turned up on each rod from under the base and tightened to make the form stand rigidly. Horns or antlers are screwed to a block of wood that has been fitted inside the top of the head of the model. Wire is fastened where the tail should join the body, and this appendage is built up around the wire with excelsior or tow and covered with papier-maché. The form is waterproofed and coated with paste, and the skin, still wet with arsenic solution, is worked and fitted to the form. The leg and body openings are sewed up, and the skin is further worked into every detail of the form and held there with pins until the paste underneath is dry. The ears are stiffened and shaped with metal linings that have been made to the shape of the natural cartilages that were removed. The lips and nostrils are worked into the slots made in the form for them. Artificial glass eyes are set in their sockets either before the skin is put on or after, whichever the preparator wishes. The hair pattern is worked out as it should be in nature and the specimen allowed to dry out for two or three weeks. Then the pins are removed, the hoofs are cleaned and oiled, the eyelids and nostrils are waxed and varnished to look damp, and the animal is ready for exhibition after any faded colors have been restored with oil paint.

**Frogs, Salamanders, Snakes, and Turtles.** There are several methods of handling this type of material. A plaster-of-Paris cast is sometimes made. When this is dry, it is shellacked and painted to correspond with the specimen's natural colors noted while the animal was fresh. Turtles are also very often mounted by removing the lower half of the shell or by cutting a piece out of the bottom of the shell through which the legs, head, and tail may be skinned. Leg bones are left attached to the toes. The skull cannot be skinned out, since the skin grows too closely to it, and the face muscles and brain are cleaned out through the neck opening and the eyes removed from the outside. Wires are placed in the legs, tail, and head and bound to the bones with thread. The muscles are replaced with tow and a coating of maché, and the skin is turned back over them. The leg, tail, and head wires are then fastened to a small piece of cork or balsa wood, the animal's legs and head are bent into the attitude it is to assume, the shell is blocked up to the height it should be in life, and the specimen is allowed to dry out. This done, the shell is replaced with wire and maché, and the faded parts are recolored after the artificial eyes have been inserted and waxed. Snake skins can be mounted in the same general way as those of birds by opening on the stomach the full length, removing the skin, and cleaning and mothproofing it in arsenic solution. The form is made by modeling or casting before the skin is removed, and the re-

*The completed habitat group includes a curved background painting, a foreground with artificial vegetation and rocks, and mounted animal specimens.*

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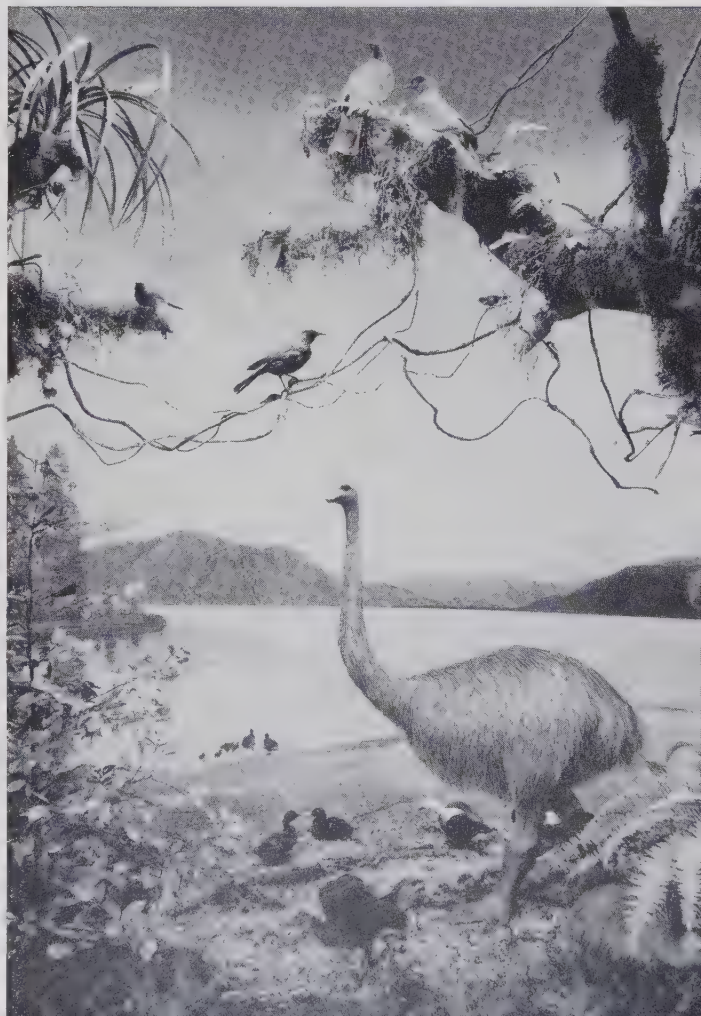


sulting form is then used to fit the skin. The colors as they were in life are restored in oils as before.

Specimens of frogs, salamanders, snakes, turtles, and even fish are being preserved at the American Museum of Natural History in New York by the paraffin infiltration method. The specimen is first set up in Bouin's solution and then dehydrated in several baths of alcohol of gradually increasing strength until absolute alcohol is reached. It is then transferred to warm paraffin for a length of time depending on the type of specimen. If any of the colors fade, they are touched up with oil paint. These several types of specimens, as well as lizards, are also made up artificially in celluloid. Detailed color notes are taken of the specimen before they fade, and a plaster mold is then made. Liquid celluloid of the proper color is painted in the mold until the correct color pattern is worked out, a reinforcement of papier-maché or wax is put in, and when it is dry the mold is taken off. The resulting cast is cleaned with water and is ready for exhibition. By this process, extremely lifelike specimens can be produced, but the method is most exacting and requires a most intimate knowledge of both subject and materials.

**Fish.** Most museums use plaster casts of fish in their exhibits. In preparing these casts, the specimen is first washed thoroughly to remove the mucus with which most fish are covered. A plaster mold is then made of the better side and as soon as the plaster is set it is removed. The fins and tail are cut off and dried between cardboard. Any air bubbles or other imperfections in the mold are filled with fresh plaster mixed with water. Salad oil is then brushed on the inner surface to act as a separator, and liquid plaster-of-Paris is poured into the mold. When this has hardened, the mold is soaked in water and broken off the cast. The dried fins and tail are fastened on the cast when it is dry. Artificial glass eyes are set in their proper positions by cutting depressions in the cast, and hot wax is used to fill in around the eye. The cast is then covered with thin white shellac. When this is dry, the natural colors are restored with oil paints. It is very important that color notes be made as soon as the fish is removed from the water. Even then, some of the delicate colors will be lost.

If the skin is to be mounted, a plaster mold is made of one side as before. The skin is taken off by making an incision in one side of the fish, and by careful handling the body can be taken out of the skin without loosing the scales. The skin is degreased in carbon tetrachloride, poisoned in arsenic solution, and replaced in the plaster mold. Papier-maché is worked into the skin while it is in the mold, and the skin of the back of the fish is given its proper shape. When the maché is hard, the fish is taken out of the mold and any flaws are touched up. The fins and tail are clamped between cardboard, and the specimen is set away to dry. Artificial eyes are set in place and any deficiency is repaired in wax. The specimen is then given a coat of thin shellac, and the colors are restored, using the color notes as a guide. If the fish is to look wet, as it does on being taken from the water, it must be given a coat of varnish.

**Crabs, Crawfish, and Lobsters.** In mounting crabs, crawfish, or lobsters, careful color notes are first taken. The top shell is then pried loose from the section containing the legs, and a core resembling that containing the legs is built, using excelsior bound with thread. The legs are taken off and cleaned, poisoned, wired, and fastened back on the excelsior body, as is done with birds. A little maché is worked into the shell and over the excelsior body, and the shell is then worked down over the body until it is in its proper position. The natural eyes are left in specimens of this type. Wires are used in the long feelers of the lobster, and sections of the large claws may be cut out on the side that is near the base to help remove the flesh from these parts. The specimen is then posed on the base it is to occupy and allowed to dry for a week or two before the colors are restored in the usual manner. G. A.

**TAY,** the longest river in Scotland. In its course of 120 mi. from the source of its remotest headstream, the Tummel, it flows from Loch Tay in Perthshire in a general east-southeast direction into the Firth of Tay. With its tributaries, the Earn, the Almond, the Isla, the Tummel, and Loch Ericht, the Tay drains a basin of over 2,400 sq. mi., and has the largest volume of water of any river in Britain. It is famous for its salmon fisheries. S. Van V.

**TAYLOR, BAYARD** (1825-1878), American journalist, lecturer, and man of letters, was born in Kennett Square, Pa., Jan. 11, 1825. As a special correspondent he traveled widely. Records of his journeys are included in the books *Views Afoot* (1846), *Eldorado* (1850), *A Journey to Central Africa* (1854), *The Lands of the Saracen* (1854), *A Visit to India, China, and Japan in the Year 1853* (1855), *Northern Travel* (1857), *Travels in Greece and Russia* (1859), *Colorado, A Summer Trip* (1867), and *Egypt and Iceland in the Year 1874* (1874). After 1854 he was popular as a lecturer. When the Civil War began, he became head war correspondent for Horace Greeley's New York *Tribune,* covering Washington and the front. In 1878 he was made Minister to Germany, where he died, Dec. 19, 1878.

Taylor achieved fame in his own day as a poet as well as a journalist. His *Poems of the Orient* (1854) influenced T. B. Aldrich and R. H. Stoddard. He wrote four novels, *Hannah Thurston* (1863), *John Godfrey's Fortunes* (1864), *The Story of Kennett* (1866), and *Joseph and His Friend* (1870). His translation of Goethe's *Faust* (1870-1871) is still regarded as standard and is his best-known work. S. E. G.

**TAYLOR, JEREMY** (1613-1667), English clergyman and religious writer, was baptized Aug. 15, 1613, at Cambridge, where he later attended Perse Grammar School and Gonville and Caius College. In 1633, after taking Holy Orders, he substituted for a friend as preacher at St. Paul's Cathedral in London and there attracted the attention of Archbishop Laud, who became his patron. After serving for a time as chaplain to Laud and to Charles I, he became rector of Uppingham, Rutlandshire, and in 1639 was married. In 1642 he received the degree D.D. at Oxford, and in the following year the king presented to him the rectory of Overstone, Northamptonshire. During the civil wars he was chaplain to the king's household until he was captured in the royalist defeat at Cardigan Castle in 1645. Later he retired to Golden Grove, Carmarthenshire, in Wales, where he was chaplain to the Earl of Carbery. His wife died in 1651 and he remarried shortly thereafter. He made occasional trips to London and was several times imprisoned by the officers of the Commonwealth. In 1658 he accepted a lectureship at Lisburn in Ireland. Although he hoped to return home at the Restoration, he was appointed bishop of Down and Connor and administrator of Dromore in 1661. He soon became a member of the Irish privy council and vice-chancellor of the University of Dublin. In all these positions he strove to improve a situation made difficult not only by the enmity of the Roman Catholics, but also by the jealousy of the Presbyterian clergy. He died at Lisburn, Aug. 13, 1667, and was buried in the cathedral of Dromore.

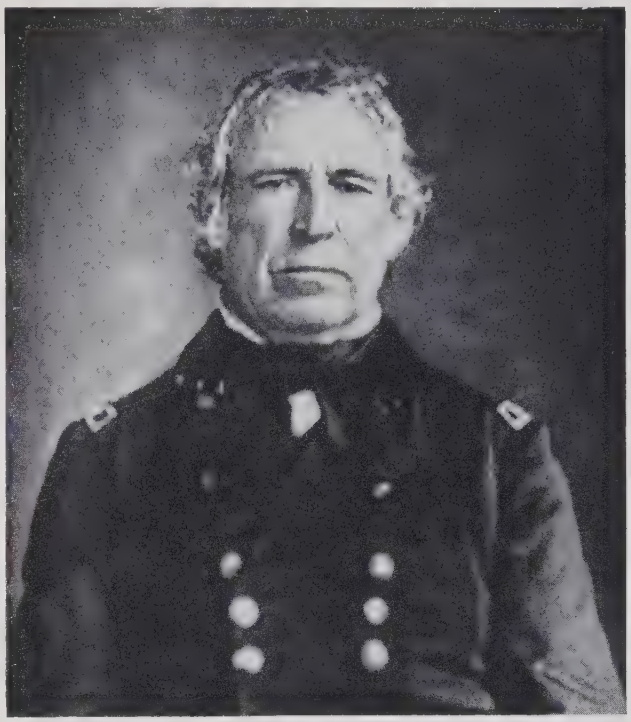
Taylor wrote voluminously on a number of religious subjects. The works on theology and on current ecclesiastical disputes lack abiding value, but there are others that by their matter or, more frequently, their manner have earned a place in literary history. *A Discourse of the Liberty of Prophesying* (1646) is a remarkable plea for toleration, reducing essential Christianity to belief in the Apostles' Creed and a good life. The most popular of Taylor's writings, however, have been *The Rule and Exercises of Holy Living* (1650) and *The Rule and Exercises of Holy Dying* (1651). Both are practical manuals of devotion and conduct, and *Holy Dying* is colored by sincere emotion. Today they are read almost exclusively for enjoyment of their rich style, not elaborate, but yet the product of conscious artistry. The same qualities are present in Taylor's sermons. H. B. W.

**TAYLOR, (JOSEPH) DEEMS** (1885- ), American composer, critic, and author, was born in New York City, Dec. 22, 1885. In his varied career, he has been a war correspondent, music teacher, translator, music critic, editor of *Musical America,* author of two books on music, narrator for the Metropolitan Opera broadcasts, commentator for the New York Philharmonic broadcasts, and moderator for Walt Disney's *Fantasia* (1940). In 1942 he was elected president of the American Society of Composers, Publishers, and Authors and was later musical adviser to the Columbia Broadcasting System. His most important works include three operas, *The King's Henchman* (1926), *Peter Ibbetson* (1930), and *Ramuntcho* (1937); the orchestral suite *Through the Looking Glass* (1918); two cantatas; several songs and choral works; and his *Elegy* for orchestra (1944). D. L. E.

**TAYLOR, THOMAS** (1758-1835), English scholar and translator, was born in London on May 15, 1758. Educated haphazardly for the Dissenting ministry, he became a bank clerk after an imprudent marriage, but continued his interest in metaphysical speculation. About 1785 he attracted attention by his exhibition of a "perpetual lamp" and by lectures on Plato; later he secured patronage which permitted his devotion to study until his death, Nov. 1, 1835, at Walworth. He published more than fifty volumes of translations, most of them the first in English, of works by Plato, Aristotle, Pausanias, Plotinus, Proclus, and minor esoteric Classical writers. In lengthy commentaries he interpreted these authors in the mystical and allegorical neo-Platonic fashion, and enthusiastically expounded vegetarian and polytheistic doctrines. Although frequently ridiculed, Taylor had numerous readers in England and America, among them Coleridge, Wordsworth, Shelley, Emerson, and many theosophists. Uncritical and inferior in scholarship, his work nevertheless marks the beginning of modern popular interest in Platonism. F. B. E.

**TAYLOR, ZACHARY** (1784-1850), twelfth President of the United States, was born in Orange County, Va., on Nov. 24, 1784, the third child of Colonel Richard and Sarah Strother Taylor, both of English ancestry. Not long after his son's birth, the elder Taylor moved to Jefferson County, Ky., where he was appointed collector of customs at the port of Louisville by George Washington. Richard Taylor, who had served in the American Revolution, soon became an influential man in this frontier community, acquiring a large plantation and representing his county in the state legislature. Taught by a private tutor, Zachary received only an indifferent education, but he gained practical experience from helping to run the family plantation. The life of a farmer apparently did not appeal to him, however, for at the age of twenty-four he accepted a commission as lieutenant in the United States Army. He was made a captain in 1810, and in that year married Margaret Mackall Smith of Maryland.

**Military Career.** Taylor followed his military career for nearly forty years, spending most of this time at various frontier posts protecting the advancing settlements from the Indians. During the War of 1812 he served with distinction



FABIAN BACHRACH

*ZACHARY TAYLOR, TWELFTH PRESIDENT OF THE UNITED STATES*

under Gen. William Henry Harrison and was brevetted a major. After the war he retired from the army when his rank was reduced, but returned two years later when he was offered a regular army commission as major by President James Madison. Thereafter he participated in the Black Hawk War (1832) and in putting down the Seminole insurrections in Florida (1837-1840), acquiring the nickname "Old Rough and Ready." In 1840 Taylor was placed in command at Fort Jesup in Louisiana. Settling his family at Baton Rouge, he purchased a plantation on the Mississippi River with the intention of combining his army career with the life of a planter, but this venture was unsuccessful, largely because of seasonal floods.

Taylor's opportunity came with the Mexican War. Ordered to guard against a possible Mexican invasion following the Texas annexation, he set out with 4,000 men in July 1845 and took up a position at Corpus Christi, at the mouth of the Nueces River. Early in 1846, on orders of President James K. Polk, he advanced to the Rio Grande, where he built fortifications across from the Mexican town of Matamoros and waited for an "overt act." This occurred when the Mexicans ambushed a scouting detachment of cavalry, and resulted in a declaration of war by the United States. Receiving reinforcements, Taylor met and defeated the Mexicans at Palo Alto and at Resaca de la Palma, north of the Rio Grande. He then crossed the river into Mexico, occupied Matamoros on May 18, and advanced southward to take the fortified town of Monterrey on September 23. By the end

of the year Taylor, with about 10,000 men, was holding a 200-mile line in northern Mexico. Instead of continuing his advance, however, he was ordered to release half his force for the major assault to be launched by Gen. Winfield Scott against Veracruz and the heart of Mexico. Despite his reduced command, Taylor was victorious in his final engagement of the war, Feb. 22-23, 1847, when he defeated Gen. Santa Anna's numerically superior but poorly led Mexican army at Buena Vista. This battle made Taylor a national hero, but he was a Whig and the Democratic administration was none too enthusiastic about his growing popularity. After the Battle of Buena Vista he was ordered to discontinue his invasion of Mexico. He had already accomplished enough to capture the public fancy, however, and was advanced as a candidate for the Whig presidential nomination in 1848 by the New York politician Thurlow Weed.

**Presidency.** In the campaign of 1848 Taylor's lack of a political past proved an asset, but his blunt statements on public policy and his assertions that he would not be a president dominated by his party worried the Whig politicians. His public popularity, however, forced his nomination on the fourth ballot over Henry Clay, Daniel Webster, and Winfield Scott. Largely because Martin Van Buren split the Democratic Party in New York, Taylor won that state, and thus the election, over his opponent Lewis Cass. His administration started inauspiciously, with neither his inaugural address nor his cabinet appointments stirring popular support. The President's lack of political experience was soon apparent, especially when he delayed making changes in his cabinet even after its integrity was compromised by the involvement of several members in a money scandal. On the other hand, he was courageously honest and sought to do what was best for the nation. His efforts toward this end were nowhere more evident than in his handling of the slavery question which had been uppermost in the country's mind since the introduction of the Wilmot Proviso into Congress in 1846. Although Taylor was a slaveholder and the one-time father-in-law of Jefferson Davis, he was remarkably impartial in dealing with this delicate issue. Assuring the South that it need not fear any attacks against slavery where then existing, he also let it be known that he would meet any overt acts of the South with force. Later he advised the territories of California and New Mexico, which opposed slavery, to seek statehood and recommended their admission to Congress provided their governments were republican in form. Moreover, he sought to curtail the ambitions of Texas for more extensive boundaries, even to the extent of military occupation of the disputed area as a part of the Federal domain until disposed of by Congress. He thus incurred the bitter opposition of many of his Whig supporters in the South, but he did not live to see the working out of the Compromise of 1850. On a hot July 4, 1850, he became critically ill from exposure to the heat and imprudent eating, and died on July 9. He was buried near Louisville, Ky. *See also* MEXICAN WAR. G. E. M.

**TAYLOR,** a borough in Lackawanna Co., in northeastern Pennsylvania, situated on the north bank of the Lackawanna River, 4 mi. southwest of Scranton. It is a suburb of Scranton, located in the anthracite-coal region, and coal mining is its major activity. It was founded in 1790 and incorporated in 1893. Taylor was named for Moses Taylor, an early railroad promoter. The borough is governed by a mayor and council. The Delaware, Lackawanna & Western Railroad and the Central Railroad of New Jersey provide transportation. Pop. 1950, 7,176.

**TAYLOR,** a city in Williamson Co., in east central Texas, situated 35 mi. northeast of Austin. It is a trading center for a cotton-raising area. Taylor was settled in 1876 and incorporated in 1890. It is governed by a council and city manager. Kenney's Fort, 3 mi. away, was the rendezvous of the ill-fated Santa Fe Expedition of 1841 when Texas attempted to extend its jurisdiction to New Mexico. Taylor is served by the Missouri-Kansas-Texas and the Missouri Pacific railroads. Besides its chief industries, which produce cotton and cottonseed oil, the city has a bedding factory, flour mills, iron and machine works, and meat-packing, cold-storage, and frozen-food locker plants. Pop. 1950, 9,071.

**TAYLOR'S SERIES.** *See* FUNCTION.

**TAYLORVILLE,** a city in central Illinois, the county seat of Christian Co., situated 27 mi. southeast of Springfield. Coal is mined in the area, and grain is the region's chief crop. Taylorville was founded in 1839 and incorporated in 1882. The city is governed by a mayor and council. A stone slab commemorates the services of Abraham Lincoln in the Taylorville courthouse. The city is served by the Baltimore & Ohio, the Wabash, and the Chicago & Illinois Midland railways. The city has hatcheries, and its manufactures include paper, stationary, greeting cards, cigars, feed and tools. Pop. 1950, 9,188.

**TAYMYR (DOLGANO-NENETS) NATIONAL OKRUG** [taimɪ'r; tai'mɪr], an administrative unit comprising the northern part of the Krasnoyarsk Krai in the central Siberian region of the Russian Soviet Federated Socialist Republic in the Soviet Union. The okrug, organized in 1930 with an area of 316,293 sq. mi., consists for the most part of a peninsula projecting into the Arctic Ocean between the Kara and Laptev seas and extending to Cape Chelyuskin, the northernmost point of the Asiatic mainland. Because the base of the Taymyr Peninsula merges into the Northern Siberian Lowlands, the highest elevations are attained in the north in the Byrranga Plateau, a ridge of folded Paleozoic rocks 984 to 1,640 ft. above sea level. The descent to the northern shore is gradual, the land being covered with a moraine, and numerous beach ridges and inland marine debris indicate a coastline still in the process of being uplifted. There are many indentations, but only those at the mouths of the Yenisey and Khatanga rivers are large. South of the Byrranga Plateau, which runs from southwest to northeast for 625 mi., are many scattered lakes, the two largest being Taymyr and Pyasina; the former is the largest lake in the Arctic.

Lying mostly north of the Arctic Circle, the entire Taymyr Okrug is in the tundra zone, but the aridity associated with high latitudes means that there are fewer swampy areas than there are farther south. The vegetation is interspersed with patches of bare rock. At Cape Chelyuskin the temperature ranges from —23° F. in December to 35° F. in July. The population of the okrug consists of a scattering of Nenetses (Samoyeds), Tunguses, and Dolgans (Nganasans), who exist on the reindeer, wolves, polar bears, lemmings, ermine, and migratory birds that inhabit the district. The Nenetses observe a type of transhumance, driving their reindeer herds to the Byrranga Plateau in the summer and retreating farther south in the winter along the Pyasina and Khatanga rivers. Dudinka on the Yenisey is the administrative center of the district and a port of call on the northern sea route. A short railroad runs east from Dudinka to Norilsk, and from Norilsk a winter trail runs overland to

Khatanga and Nordvik to the northwest. Little geologic work seems to have been conducted in the region, but it is known that there are many salt domes, particularly near Khatanga Bay. Those at Nordvik produce excellent salt. Traces of sulphur and petroleum have been reported, and along the Taymyr River are deposits of gold and graphite. Pop. (est. 1954), 30,000. W. S. V.

**TBILISI** [tpɪ'lɪsɪ], formerly Tiflis, a historic, commercial city and the capital of the Georgian S.S.R., in the southwest Soviet Union, 270 mi. northwest of Baku. It lies on both banks of the upper Kura River at 1,350 ft. above sea level in a mountain-ringed basin of the Caucasus Mountains. Though the actual origins of Tbilisi are obscure, it seems to have begun in the fourth century in the vicinity of several hot mineral springs. In the fifth century the capital of Georgian rulers was transferred from Mtskhet to the town. Located as it was on one of the world's great crossroads of invasions and migrations, it was repeatedly assaulted and plundered during the seventh, eighth, and ninth centuries by Persians, Greeks, and Arabs. It was completely devastated in 828 by the Khazars. Pillaged later by Turks, it was taken by the Mongol conqueror Tamerlane in 1387. When Persia attempted to take the city in 1795, Georgia accepted Russian "protection" and was annexed by Russia in 1799. Tbilisi remained the seat of the tsarist government in the Caucasus from 1801 to 1918, and it was a White Russian stronghold during the civil war following the 1917 Revolution. Joseph Stalin was born near Tbilisi in 1879.

The town is compared with Cairo in its contrasts of the old and the new and its extremely cosmopolitan atmosphere. The busy, colorful market section and bazaars are a mixture of many peoples and tongues. The Zion cathedral dates from the fifth century. Institutions include a state university, academy of sciences, institute of medicine, museum, theatre, and schools of agriculture, forestry, industry, technology, art, and music. Tbilisi is the southern terminus of the famous Georgian military road over the Caucasus Mountains from Dzaudzhikau, and it also is located on the southern Black Sea-Caspian railway. As the agricultural and economic center of the Transcaucasian region it has a large trade in a variety of items. A hydroelectric station on the Kura near the city furnishes power to the city's numerous industries, whose manufactures include textiles, shoes, clothing, silk, lumber, paper, furniture, chemicals, film, cottonseed oil, margarine, machines, oil industry equipment, tobacco products, leather goods, tapestry, and distilled spirits. Pop. (est. 1954), 580,000. C. C. H.

**TCHAD LAKE.** *See* CHAD LAKE.

**TCHAIKOVSKY, PYOTR ILYICH** [tshaikɔ'fskɜɪ; tshaikɔ'fski] (1840-1893), the most famous of all Russian composers, was born May 7, 1840, at Votkinsk, the second child of five sons and a daughter of music-loving parents. Tchaikovsky's musical ability manifested itself early, and when he was less than five years old he composed with his older sister a song about his mother; a few months later his governess started him in his first music lessons. As a child Tchaikovsky was sickly and extremely sensitive; he was also intensely affected by music. His parents, however, wished him to become a lawyer, and at the age of ten he was placed at a school in St. Petersburg in preparation for his enrollment at the law school in the same city two years later. At the same time, however, he continued his study of music. Immediately on graduating from law school Tchaikovsky was appointed a clerk in the Ministry of Justice, where he remained from his nineteenth until his twenty-third year. But music came to dominate him more and more, and after a European trip on which he visited Berlin, Antwerp, Brussels, London, Paris, and other cities, and as a result of his serious lessons in harmony with Nikolai Zaremba, he became convinced that he was to be a composer and entered the St. Petersburg Conservatory at the age of twenty-two. Tchaikovsky spent three years at the Conservatory, leaving the Ministry of Justice and supporting

PYOTR ILYICH TCHAIKOVSKY

FROM A DRAWING BY LOUIS LUPAS

himself by teaching piano and theory; his teachers here were Anton Rubinstein in composition and orchestration, and Zaremba in harmony and counterpoint. After his graduation Tchaikovsky was engaged by Nikolai Rubinstein, the brother of Anton, as professor of harmony at the Moscow Conservatory. During that year he added a major work, the First Symphony, to the numerous shorter compositions he had already written for piano, voice, chorus, and ensembles.

Tchaikovsky's nearly twelve years as a teacher at the Moscow Conservatory were most eventful. During this time he fell in love with Désirée Artôt, a French opera singer appearing in Moscow, only to be jilted by her. He also became a music critic for a Moscow newspaper, a position which he held for several years, and visited the Wagner Festival at Bayreuth, meeting Franz Liszt and endeavoring to see Richard Wagner there. His singular friendship with Nadezhda von Meck, who aided him financially and whom he never met, dates from this period, as does his marriage. This marriage, doomed from the start by Tchaikovsky's sexual abnormality, proved a disastrous experience and, though it lasted only a few months, it drove the composer to attempt suicide. In spite of extreme spiritual suffering and overwhelming material hardships during most of this turbulent period, however, Tchaikovsky wrote a considerable amount of music, including some of his greatest works. To these years belong the first four symphonies; the First Piano Concerto, originally dedicated to Nikolai Rubinstein, but after Rubinstein's severe criticism of it rededicated to Hans von Bülow; three string quartets; five operas, the last of which was *Eugene Onegin,* his best-known opera; the ballet *Swan Lake;* and much other music.

Through the generosity of Mme von Meck, Tchaikovsky was freed from all financial worries at the age of thirty-seven; he resigned his position at the Conservatory in the following year and until his death was able to concentrate solely upon composition. His development as a composer was slow, and fame for many years eluded him, but he was

a hard and systematic worker and produced a large variety of compositions each year. Financially independent, Tchaikovsky was also able to travel in European countries and on such trips his restless nature was temporarily calmed. His independence also provided him with the opportunity to study conducting, and he made his first appearance as a conductor in a concert of his own works in St. Petersburg at the age of forty-seven. His success in this concert was a surprise to him, for he believed he possessed no talent for conducting, but it led to an engagement for a European tour the following year. On this tour, Tchaikovsky appeared with great success in Paris, Berlin, Leipzig, Prague, and elsewhere, conducting, as before, only his own works, but his nervous temperament and retiring nature, in addition to the inconveniences of a pressing schedule, permitted him but little satisfaction from the tour. Far more important to him was his acquaintance with most of Europe's famous musicians, among them Brahms, Gounod, Massenet, Busoni, Paderewski, Grieg, Dvořák, Fauré, and numerous others.

At forty-eight, Tchaikovsky composed one of his most popular symphonies, the Fifth, and in the next year completed his second ballet, *The Sleeping Beauty,* which at first was not successful. During this period of financial independence, he also composed several other works which have since helped to establish his fame, among them his overtures, *Romeo and Juliet* and *1812,* and the popular *Nutcracker Suite.* In 1890 his friendship of fourteen years with Mme von Meck, maintained by mutual agreement solely through a voluminous correspondence, was ended abruptly by her, for reasons which remain mysterious. In the same year he finished his ninth opera, *The Queen of Spades.* Shortly afterwards Tchaikovsky visited America and at the invitation of Walter Damrosch came to New York in 1891 to conduct the New York Symphony Society Orchestra at the festival concerts inaugurating Music Hall, now Carnegie Hall. He also conducted in Baltimore and Philadelphia. Tchaikovsky enjoyed his short stay in the United States, but he departed for Russia in an exhausted condition brought on by what for him was the too-fast tempo of American life. In 1893 Tchaikovsky began work on his most famous symphony, the Sixth or *Pathétique.* It was also to be his last; while he was still working on it, he traveled to England to receive an honorary degree from Cambridge University, but shortly after his return to Russia and the completion of the symphony, Tchaikovsky died of cholera in St. Petersburg, Nov. 6, 1893. W. La.

**TCHEKHOV, ANTON PAVLOVICH.** *See* CHEKHOV, ANTON PAVLOVICH.

**TCHELITCHEW, PAVEL** [tshɛ'lɪtshɛf] (1898- ), Russian painter and stage designer, was born in Moscow on Sept. 21, 1898. After escaping from Moscow at the time of the Russian Revolution, he received his chief training in art while living in Kiyev between 1918 and 1920. After sojourns in Odessa, Constantinople, and Sofia, he arrived in Berlin by 1921 and soon won acclaim as a stage designer. In 1923 he went to Paris, where he remained until 1934, when he established himself in the United States.

Tchelitchew began his career under strong influence from the abstract schools of painting. In Kiyev he was associated with Alexandra Exter, a pupil of Fernand Léger, and he studied under Bogomazov, a Cubist, as well as under the Constructivist stage designers Rabinovich and Tchakrigine. His experience with these artists never ceased to serve him as discipline in matters of structural analysis, but he soon adopted a representational approach in his work. By 1926 he had evolved a mature style, and in the same year, with Eugène Berman and Christian Bérard, he launched the Neo-Romantic movement, which embodied a program designed to restore allusive and humanistic content to painting.

Tchelitchew's subsequent production is characterized by an acutely imaginative examination of reality, which, as in the *Head of Gold* (Edward James Collection), seeks to uncover new psychological and visual aspects of man and nature. His color is rich and sensuous, with warm tints in predominance, and his light is unearthly in its penetrating radiance and luminosity. These qualities are especially well displayed in *Hide and Seek* (Museum of Modern Art, New York). In some of Tchelitchew's paintings, multiple images are laid kaleidoscopically in single dominant forms, and the elements of composition are seen from different points of view and in distorted perspective, as in *The Clown* (Sherman Kent Collection, Washington, D. C.). Thus his work constantly reveals not only extreme fantasy, but a daringly original vision coupled with unusual mastery of structural design. M. J.

**TEA,** a beverage derived from the leaves of *Thea sinensis,* a member of the tea family. Tea drinking has increased for sixteen centuries until today it is the most widely drunk hot beverage. Annual production approximates 2,000,000,000 lb. The leaves contain 1 to 3 per cent caffeine (theine) and a little theophylline. Weight for weight, tea leaves have more than twice as much caffeine as coffee beans, but a cup of coffee generally has more of the alkaloid than a cup of tea. One pound of tea leaves furnishes about 250 to 300 cups whereas one pound of coffee makes only 40 cups. Powdered, instantaneous tea, and compressed tea tablets are recent forms of tea on the American market.

**Botany.** Tea is an evergreen plant 15 to 20 and sometimes 30 ft. high in the wild state. It is indigenous to Assam and parts of China and Japan. Profusely branched, it bears very numerous alternate, elliptical or lanceolate, short-stemmed leaves, 2 to 5 in. long at maturity. The leaves have serrate margins, and the flowers are white, slightly fragrant, and about one inch across the widely spread, deeply cut corolla lobes, of which there are five to nine. The fruit is a woody capsule containing a globose seed in each cavity.

**History.** According to legend, a Chinese philosopher discovered the tea beverage when leaves fell into his campfire pot of boiling water and sent up a delicious aroma. It was introduced into Continental Europe by the Dutch in 1610, and into England in 1664. London is the tea capital of the world, and the average Briton drinks five cups a day. Tea was first sold in Boston in 1714 and in New York in 1728. Tea culture began in China in prehistoric times, in Japan in the Middle Ages, and in India and Ceylon about 1870. In the 1880's tea was grown successfully in North Carolina and Texas, but abandoned because of the labor cost. Before World War II tea was cultivated on large areas in China, Ceylon, Formosa, India, Japan, Java, Pakistan, and Sumatra. Since World War II it has been grown commercially also in Australia, Bolivia, Brazil, Guatemala, New Guinea, Peru, the Soviet Union, and South Africa.

**Agriculture.** Tea is grown in open fields or on terraced hillsides. The plants are kept pruned to bush size except the seed trees, which are allowed full natural growth. Numerous varieties have been produced through long cultivation. In the Orient the plant thrives best under a rainfall of 90 to 200 in. a year. It prefers a warm climate (50° to 90° F.) at moderate altitudes. Acid soil, pH 4.5 or less and not

over pH 5.57, produces the best growth. Plants are pruned slightly each year, but drastically in the spring of the third year, and collar-pruned (almost to the ground) in the tenth year. This results in suckers sprouting up from underground and produces a large bush with several main stems; such a plant yields a crop every forty days. The average life of a tea plant is twenty-five to fifty years.

**Production and Trade.** Of the 2,000,000,000 lb. of tea produced annually, China is the leading producer (700,000,000 lb.). India is the leading exporter (322,000,000 lb.), but second in production; Ceylon is third in production. Following India in export volumes are the East Indies (150,000,000 lb., second); China (100,000,000 lb., third); Japan (40,000,000 lb., fourth); and Formosa (20,000,000 lb., fifth). The United Kingdom buys 440,000,000 lb., leading the world in importation. The United States imports 90,000,000 to 100,000,000 lb.; Australia, 50,000,000 lb.; the Soviet Union, 45,000,000 lb.; and Canada, 40,000,000 lb. South Africa supplies itself with only one twentieth of its tea requirements and imports large quantities. Small amounts are produced in other geographic areas.

**Harvesting and Processing.** The first profitable "flushing" (complete picking) occurs in the fifth year. Native pickers pluck the bud and the first two leaves of all twigs on the bush. This procedure constitutes fine plucking and yields the finest tea. If the third leaf is tender, it is plucked off at the same time. This is medium plucking. When the fourth leaf is included, it is coarse plucking.

Leaves for black tea (fermented) are spread on withering racks (chungs) to allow proper oxidation. Then the leaves are rolled to break cells without tearing leaves badly. This allows further oxidation after which the leaves are dried (fired) in baskets over charcoal fires or in tea-firing machines in modern buildings. Oolong tea is semifermented; and leaves for green tea (unfermented) are steamed (panned) to stop fermentation.

"Pekoe" is Chinese for "white hair" and referred originally to the youngest leaves covered with down. Orange pekoe was formerly scented with orange blossoms in China. Today, pekoe is a commercial grade which results from sifting, after firing, through a sieve with a certain sized mesh. Orange pekoe is a better grade than pekoe. Souchong is a poorer grade than either pekoes.

Principal kinds of Indian tea in northern India are Assams, Darjeelings, and Dooars. In Ceylon the types are high-grown, medium-grown, and low-grown teas. In China the classification is China greens, China blacks (Congous), and Oolongs, scented and compressed. North China varieties are blacks (Keemuns, Ningchows, Ichangs), Burgundies, and South China blacks (Congous, red leaf Congous, Kaisows, and Foochows). The clarets are Chinese teas. Netherland Indies teas are black teas known as Java and Sumatra, with exports also bearing the name of the tea garden source. Brazilian tea types are equivalent to broken orange pekoe, orange pekoe, pekoe, and broken tea.

Professional tea-tasters can identify the source (country and district) and sometimes even the season in which the leaves were picked. Tasters sip but seldom swallow tea. Americans depend upon the taste sense of fewer than forty men as the guide for wise purchasing and blending of imports each year to maintain uniformity in the brands on the market.

**Miscellaneous Uses.** Tea leaves were first used as a vegetable relish, and are still pickled and so used in Burma. Chinese women press tea leaves into solid blocks for export by camel caravan to the interior of Mongolia, where brick tea is stewed in water until softened and then eaten with butter or with *tsamba* (ground, parched wheat or barley). Certain Mongolian tribes add a pinch of salt to beverage tea. Tea is a part of religious ceremonial rituals in China and Japan. Taoists include it in an elixir of immortality, and Buddhists consume it during meditation hours. Cake-tea has been made in China since before the T'ang Dynasty (618-907). Steeping tea, the general practice today, was developed during the Ming Dynasty (1364-1644). In Japan white jasmine flowers, called "Mokle," are added to make the commercial "jasmine tea." In Siam tea leaves are chewed. Arabs flavor their tea with mint and this mixture is available on the American market. Most commercial caffeine is extracted from tea waste and sweepings; it is used in medicine and in the soft drink industry. R. H. C.

**TEACHERS COLLEGE,** a college offering professional courses for teachers and administrators of all grades and all departments of the United States educational system, from nursery school through the university. Founded in 1888 and chartered by the Regents of the University of the State of New York in 1889, Teachers College became a part of Columbia University in New York City in 1897, although maintaining its separate corporate organization.

Programs may be planned leading to the B.S., the M.A., the M.S., the Ed.D., or the Ph.D., conferred by Columbia University. The courses offered by Teachers College are organized under four divisions: foundations of education, administration and guidance, instruction, and nursing education. In addition the college offers interdivisional programs of study in such fields as community service, group work, religious education, intergroup relations, communication arts, co-operative extension service, education for marriage and family life, and recreation. Teachers College maintains a bureau of publications to make available the research studies of its faculty, staff, and doctoral candidates. The bureau also publishes the *Teachers College Record,* teacher reference materials, tests, yearbooks, monographs, films, and syllabuses.

Dormitory and dining facilities are provided. For students not living in the college residence halls, furnished rooms and apartments in the neighborhood are available. Fellowships, scholarships, and loan funds are offered. Opportunities for self-help are available in many fields. *For statistics see* COLLEGES AND UNIVERSITIES. J. R. To.

**TEAK,** a tall, stately forest tree, *Tectona grandis,* of the verbena family, renowned for its excellent and durable timber. It is a native of southeastern Asia; commercial supplies of teak lumber come from India, Burma, Siam, and Java. Much of the timber has been depleted by cutting. The tree, which grows to a height of 100 to 150 ft. and has a trunk 3 to 8 ft. in diameter, bears large, oval, deciduous leaves, numerous white or bluish flowers in terminal clusters, and globular fruits about the size of cherries, containing oily seeds. Teak wood is hard, heavy, and strong, and the brown heartwood is nearly immune to decay. Its shrinkage in drying is very small, close to that of mahogany, and it is used in the United States and Europe chiefly for the decking of large and expensive vessels; for cabin interiors of small pleasure boats, ships, and yachts; and for the interior finish of fine residences, club rooms, and bank buildings. W. D. B.

**TEAL,** a name loosely applied to almost any small (14 to 17 in.) species of river duck. There are about fifteen species widely distributed throughout the world. The best known is the common green-winged teal, *Nettion carolinense,* a beau-

tiful species with green and chestnut head and a conspicuous patch of metallic green on the wing. It breeds in temperate regions around the Northern Hemisphere and is found in winter in most parts of the United States. Two other birds known in America as teal, but more properly called blue-winged ducks, are the blue-winged teal, *Querquedula discors,* and the cinnamon teal, *Q. cyanoptera.* The former closely resembles a diminutive shoveler; the latter is chestnut, with a sky-blue wing patch. Teal are vegetarian ducks and occur in large flocks where food is plentiful. They are favorites with sportsmen because of their rapid rise from the water and their swift flight. H. G. De.

**TEANECK,** a township in Bergen Co., in northeastern New Jersey, situated on the Hackensack River, across the river from Hackensack. The first land grants including the township's site were issued by the Dutch government, and in 1669 the English government included the same territory in a grant to Captain John Berry. The majority of the early settlers were Dutch and French Huguenots. The community, which includes West Englewood, became an independent township in 1895. Local government is administered by a manager, mayor, and council. Transportation is provided by the West Shore division of the New York Central System. It is a strictly residential community, whose residents commute to work in the surrounding industrial cities of New Jersey and in New York City, 12 mi. distant. Pop. 1950, 33,772.

**TEA OIL TREE,** a small evergreen tree, *Camellia sasanqua,* of the tea family, bearing attractive flowers and shining leaves much like the cultivated *C. japonica.* Native to China and Japan, it is grown for its seed, which yields an oil similar to olive oil. *See also* Camellia. R. P. T.

**TEASDALE, SARA** [ti′zdel] (1884-1933), American poet, was born Aug. 8, 1884, in St. Louis, Mo. After private schooling and a period of travel in Europe and the Near East, she settled in Chicago. There she married Ernst B. Filsinger in 1914, but divorced him in 1929 and later moved to New York. There, except for visits to France and England, she lived until her death, Jan. 29, 1933.

Primarily a lyric poet, interested chiefly in committing personal emotions to verse, Teasdale adhered to no school and was little affected by contemporary currents of revolt and experimentation in poetry. Her unmistakably feminine lyrics frequently resembled those of Christina Rossetti, whom she greatly admired, and this similarity may be traced in her most familiar works: *Sonnets to Duse* (1907); *Rivers to the Sea* (1915); *Love Songs,* which was awarded the Columbia University Prize in 1917; *Flame and Shadow* (1920); *Dark of the Moon* (1926); *Strange Victory* (1933); and *Stars Tonight* (1930), a book of poems for juveniles. F. B. T.

**TEASEL** [ti′zəl], common name for a genus, *Dipsacus,* of stout, coarse, hairy or prickly biennials, which includes about 15 species native to North Africa, Asia, and Europe. Two of these species have become naturalized in North America. The European field teasel, *D. sylvestris,* is found in the eastern United States, where it has become widespread, while the fuller's teasel, *D. fullonum,* is grown to a limited extent in central New York for commercial purposes. The latter plant, when ripe, has flowering heads or "teasels" which are 3 to 4 in. long, cylindrical in shape, and densely beset with spiny, rigid scales; it grows to about 6 ft. tall. The heads are used in machines for raising the nap on cloth, a process called "fulling." For this purpose it is grown extensively in Europe. M. G. W.

**TEAZLE, LADY** [ti′zəl], the young and, at first, giddy wife of Sir Peter Teazle in the comedy *The School for Scandal* by Richard Brinsley Sheridan. By the end of the play she is reformed and reconciled to her husband. A. H. N.

**TECHNETIUM** [tɛknɪ′shiəm], symbol Tc, formerly called masurium, Ma, atomic number 43, at. wt. 99, the third member of Group VII-A, which includes manganese and rhenium. It was identified in the X-ray spectra of certain platinum and columbium compounds in 1925 by Noddack, who then discovered rhenium also. The artificial product was prepared at the University of California in 1937 by Perrier and E. Segrè by the bombardment of molybdenum with neutrons or deuterons. The name, which means artificial, was suggested by F. Paneth, and was adopted in 1947. H. N. A.

**TECHNOCRACY.** *See* Political Science and Philosophy (*Political Philosophy*).

**TECUMSEH** [tɪkʌ′msə] (c.1768-1813), Shawnee Indian chief, was born about 1768 in the valley of Miami, a few miles from Springfield, Ohio. As a warrior, he was opposed to savage acts, such as scalping, and had the reputation of keeping his word. In 1805, he and his brother resolved to form an Indian confederation to prevent further ceding of land to the American whites, and in 1810 he told William H. Harrison, Governor of Indiana, of his plan to wage battle if the lands were not restored to the Indians. Tecumseh obtained the support of the red men, and after Harrison had won the Battle of Tippecanoe, Ind. (Nov. 7, 1811), Tecumseh joined forces with the British in Canada in June 1812 and became a brigadier general. Oliver Hazard Perry's victory of Sept. 10, 1813, on Lake Erie made it clear to Tecumseh that the British intended to retreat eastward, but Tecumseh himself, unable to withdraw because of his fidelity to the men he had enlisted, remained and was killed at the Battle of the Thames, Oct. 5, 1813. W. E. A.

**TECUMSEH,** a town in Essex Co., Ontario, Canada, 5 mi. east of the city of Windsor, on Provincial Highway 39 and the Canadian Pacific Railway. It was incorporated as a town in 1921. Two-thirds of the inhabitants are of French origin. Pop. 1951, 3,543. D. F. P.

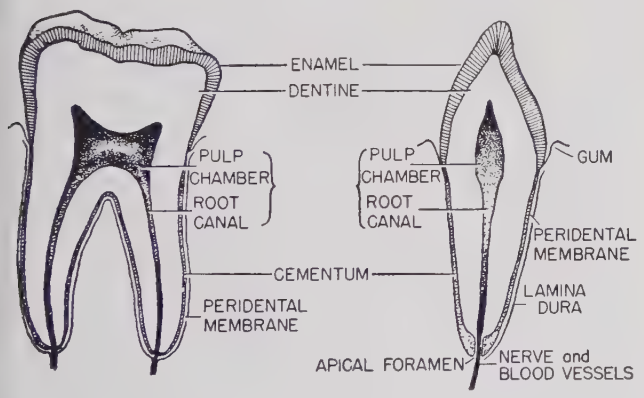
**TEDDER, ARTHUR WILLIAM (FIRST BARON TEDDER OF GLENGUIN)** (1890- ), British air marshal, was born in Stirlingshire on July 11, 1890, and was educated at Magdalene College, Cambridge, where he received his degree in 1912. On the outbreak of World War I in 1914 he was commissioned in the Dorsetshire Regiment but in 1916 transferred to the Royal Flying Corps; he became a permanent member of the Royal Air Force in 1919. In 1926, he was appointed to the Air Ministry, in 1929 he became a member of the directing staff of the R.A.F. Staff College, and in 1932 he was made commander of the Air Armature School at Eastchurch. From 1936 to 1939 he was air officer commanding the R.A.F. in the Far East and in 1939 became director general of research and development for the Air Ministry. In 1940 he was appointed deputy air officer commanding in the Middle East and, following the evacuation of Crete, was promoted to air officer in chief. He was Deputy Supreme Commander under General Dwight Eisenhower from 1943 to 1945 and was largely responsible

for the rout of the Germans and Italians in Tunis. In 1946 he received a peerage and was appointed Chief of the Air Staff and First and Senior Member of the Air Council. His publications include *The Navy of Restoration* (1915) and *Air Power in War* (1948). R. T.

**TEETH,** the hard, bonelike structures found in the mouth and used for the mastication of food. Each tooth has a crown, which projects from the gums; a root or roots, which are normally contained within a socket or alveolus; and a neck, which is a constricted portion between the root and the crown and is actually part of the root.

**Types of Dentition.** The teeth of man vary in shape from the incisors to the molars and are referred to as heterodont. Some mammals, such as the armadillo of South America and the dolphin, have teeth which are all alike in form. Man is equipped with two dentitions or sets of teeth (diphyodont). Animals like the rat have but one set of teeth (monophyodont), while the shark and crocodile may acquire many sets (polyphyodont). The first series of teeth in man is called the deciduous dentition and the second series the permanent dentition. The deciduous teeth are sometimes called the baby or milk teeth. They appear in childhood, approximately between the ages of six months and two and a half years. They begin to shed at the age of six years and are gradually replaced with the permanent dentition. Between the ages of six and twelve years there is a mixed dentition of deciduous and permanent teeth in the mouth.

**Types of Teeth.** The teeth arrange themselves in an arch which varies in different individuals. Those in the upper jaw are called the maxillary, and those in the lower jaw, the mandibular teeth. Based on original function, the teeth have been divided into three groups: the incisors, which are used primarily for cutting; the canines and premolars (bicuspids), which originally were used for the prehension of food and today function in a cutting capacity similar to the incisors; and the molars, which are used for grinding.

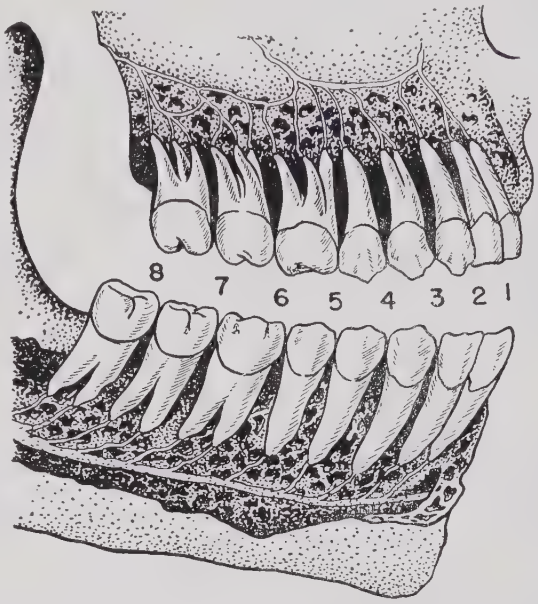



*Cross sections of two types of teeth.*

**Tooth Structure.** The bulk of the tooth structure is composed of dentine, which is covered by enamel on the crown and by cement on the root surface. Within the tooth is a space called the pulp cavity.

The enamel is a hard, dense substance composed primarily of inorganic material and a small amount of organic matter. Dentine, also a hard substance, though softer than enamel, is chemically very similar to bone. The pulp connects with the body through the openings at the end of the root canals, called the apical foramina. An artery, a vein, and a nerve pass through this foramen into the canal of the root and up through the canal to the pulp chamber located in the crown of the tooth.

The roots of the teeth are set in sockets or alveoli and are held in place by tiny fibers which connect with the cement covering the root surface of the tooth and the bone lining the socket. This filmlike tissue between the root and the socket is called the dental periosteum. The thin layer of dense bone lining the socket is called the lamina dura. The gum tissue surrounding the neck of the tooth is attached to the tooth and helps to support it.




*The upper and lower jaws of the human head showing the roots and crowns of the teeth: (1, 2) incisors; (3) canines; (4, 5) bicuspids; (6, 7, 8) molars*

**Human Dentition.** The complete deciduous dentition numbers twenty teeth. These include four incisors, two canines, and four molars in each jaw. The first incisors make their appearance between six and eight months of age. The second incisors erupt in the seventh to ninth month. The first molar appears next, between the fourteenth and eighteenth month; and the canines, which are situated between the second incisor and first molar, erupt in the sixteenth to eighteenth month. The second molar, which is the last tooth in the arch, erupts between the eighteenth and twenty-fifth month.

The first and second deciduous incisors and the canines in the upper and lower jaw have one root each. The upper first and second deciduous molars have three roots, and the lower molars two roots each. These roots diverge considerably to allow room for the permanent premolars to develop between them. When the deciduous teeth are to be replaced, there is a breakdown and absorption of the roots and of the supporting structures of the teeth. With the attachment destroyed, the teeth are shed.

The complete permanent dentition has thirty-two teeth. These include four incisors, two canines, four premolars (bicuspids), and six molars in each jaw. The first permanent incisors erupt at the age of six to eight years; and the second incisors between seven and nine years. The canines appear between ten and twelve years. The first premolar, which replaces the deciduous first molar, erupts during the ninth to eleventh year; while the second premolar, replacing the sec-

ond deciduous molar, erupts between the eleventh and thirteenth year. The premolars are named for their position in the mouth in front of the permanent molars. The first permanent molar appears behind the second deciduous molar in the fifth to seventh year. The permanent second molars erupt in the twelfth to fourteenth year. The third molar, or wisdom tooth, as it is commonly called, may erupt any time after the sixteenth year. Very often the mandible is not sufficiently developed to accommodate these teeth and surgical removal is indicated. Third molars may be completely absent in some individuals.

The four incisors and two canines in the upper and lower jaws are single-rooted teeth, as are the second premolar in the upper jaw and the first and second premolar in the lower jaw. The first premolar in the upper jaw usually has two roots. The first and second molars in the upper jaw have three roots—two toward the buccal (cheek) side and one toward the lingual (palate). The first and second molars in the lower jaw have two roots, one on the mesial (front) and one on the distal (back) portion of the crown. The third molars in the upper jaw present many irregularities in the roots. The roots may be fused or there may be three roots, similar to the first and second molars. The lower third molar usually has two roots that are fused together.

## DISORDERS OF THE TEETH AND THEIR TREATMENT

Teeth are subject to a variety of disorders. Faulty development may result in malocclusion. Caries produces decay of the hard structures. The pulp may become infected. Diseases of the supporting tissues affect the teeth. Missing structures must be replaced and existing defects corrected. Each type of disorder requires special treatment.

**Orthodontia.** Orthodontia is the phase of dentistry which deals with the position and relationship of the teeth in the upper and lower jaws. It attempts to establish the best possible relationship for chewing efficiency, swallowing, proper breathing habits, and physical appearance. Edward Hartley Angle, one of the pioneers in orthodontia, established the basic concept of an ideal normal occlusion, which is based on an understanding of the shapes of the various teeth and their particular place and function in the dental arch.

On the chewing surfaces of the premolar and molar teeth there are cusp and groove formations. From the top of the cusp down, an inclined plane is formed. This inclined plane also exists from the cutting edges of the incisors and the cusp of the canines. It is the relationship of these inclined planes in the lower and upper jaw to each other which contributes to the chewing efficiency of the teeth.

The prenatal causes of malocclusion include heredity, diseases (syphilis), abnormal development, failure to develop certain teeth, intra-uterine pressure, and nutritional deficiencies in the mother. After birth, nutritional deficiencies, diseases of childhood, and disturbances in the endocrine system may be responsible. Other factors causing malocclusion include losing the deciduous teeth too early, or retaining these teeth too long. Habits such as thumb sucking and lip biting may contribute to a poor occlusion.

Treatment in orthodontia includes establishing the best condition for normal growth and development and eliminating any conditions that may interfere with this process. Orthodontic appliances may be necessary. The teeth are brought into position in the upper and lower jaws for maximum efficiency and cosmetic benefit.

**Dental Caries.** Dental caries is a disease process which results in a breakdown of the hard structures of the teeth. The protective covering of enamel and the dentine underneath are attacked by acids produced in the mouth. The inorganic salts, primarily calcium phosphate, which make up the main portion of the enamel and dentine are broken down, with the resulting decalcification of the tooth. The remaining organic matrix in the enamel and dentine is dissolved by enzymes in the mouth. This process accompanies and follows the mechanism of decalcification.

There is general agreement that carbohydrates are changed into acids through bacterial activity. The bacteria involved are the acid-producing lactobacilli and streptococci. These bacteria produce enzymes which react on carbohydrates and convert them into lactic and other acids which are formed in all mouths, regardless of the presence or absence of caries. If the saliva fails to neutralize the acid, decalcification will follow. Cavities usually begin on the surface of the teeth on which bacteria can attach themselves and remain undisturbed.

Immunity to dental caries, while extremely rare, does exist in some mouths. In the United States, 2 to 5 per cent of the adult population demonstrate immunity to dental caries. Some races, such as the Eskimo, and persons living in certain areas of India, show a remarkable absence of dental caries. A change in the environment and assumption of living habits that approximate Western civilization will often produce a marked breakdown in the immunity, with subsequent decay. The presence of carbohydrates in the diet is an essential factor in the development of dental caries in most people. During World War II, when the use of sugar was restricted in Finland, Norway, Sweden, and Denmark, there was a definite decrease in caries which was apparently directly related to the sugar restriction. On the other hand, some individuals may consume large amounts of sugar and yet remain relatively caries-free. In these cases, the possible neutralizing acid factors in the saliva, the rate of salivary flow, and the relationship of the teeth in the dental arch are of importance. The acid formation from the breakdown of sugars does not have to be completely neutralized; rather the proportion must be reduced. The amount of flow of saliva exerts a considerable influence on the amount of acid that may be neutralized. The length of time that food remains in the mouth is a contributing factor to the amount of acid formed, and the position of the teeth contributes to the retention of food for longer periods. In this connection, orthodontia is an important factor in preventive technique to minimize tooth decay. Brushing the teeth immediately after eating will also help reduce dental decay.

*Treatment of Dental Caries.* In order to arrest dental caries, it is necessary to remove surgically all the decayed tooth structure. The tooth must then be prepared to receive a filling which will restore the tooth to normal function. The outline of the filling is based on a preventive approach to recurring decay. The filling materials used are gold foil, cast gold, baked porcelain, synthetic cements, plastics, and silver amalgam. The type of filling to be used is dependent on the requirements of the particular restoration.

*Fluorides.* It has been demonstrated that persons living in areas with a concentration of fluoride in the water supply show a marked resistance to dental caries. If the concentration of fluoride is too high, it may produce a disease of the teeth called fluorosis, in which the enamel takes on a mottled, brown stain. A lesser concentration of fluorides, however, will produce a beneficial effect, and many areas in the United States are adding small percentages of fluoride to their water supplies.

The fluorides are also being used in a 2 per cent solution of sodium fluoride for direct application on the surfaces of the teeth as a preventive for dental caries. Experiments have shown that this is effective only on teeth recently erupted. Clinical results have shown a definite decrease in the number of cavities after these applications. Another method includes the increased supply of fluorides through daily supplements in the diet. There was not enough evidence in 1950 to evaluate these results conclusively.

The pulp of the tooth becomes infected when it is exposed to the micro-organisms present in the mouth. Any physical injury to a tooth may also cause an infection of the pulp to develop. Once this infection has taken place, there are only two alternatives for treatment. Either the tooth must be removed or root-canal therapy must be instituted to preserve the tooth.

**Root-canal Therapy.** Root-canal therapy is a method by which the infected pulp is removed from the tooth and the root canals and pulp chamber are disinfected and filled. This is done to prevent any infection from gaining access to the surrounding structure beyond the apical foramen of the roots. With this method it is possible to retain the usefulness of the tooth in the mouth, without causing harm to the body generally. The materials used for the filling of root canals include the dental cements, metals, and gutta-percha.

**Periodontia.** Periodontia is the study of the supporting structures of the teeth. Diseases involving the attachment of the teeth are probably as old as man. Destruction of the alveolar bone around the roots of the teeth and the presence of calculus deposits on the roots have been discerned on skulls of the earliest cave dwellers.

Some of the signs of periodontal disease include changes in the color, form, and texture of the gum tissue surrounding the teeth. X ray may reveal changes in the bone structure around the roots. An exudate may appear from the gum margin at the neck of the tooth, and the teeth may exhibit an abnormal looseness.

Periodontal disease may be produced by improper occlusion, where forces resulting from chewing cause injury to the attachment apparatus of the teeth. Improper brushing, diet, habits such as nail biting and lip biting, calculus deposits on the roots of the teeth, grinding, poorly constructed fillings, endocrine disorders, and allergies may also be contributing factors. Treatment includes removing the causative factors and correcting the occlusal relationships of the teeth.

**Prosthetics.** Professionally defined, "prosthesis is the science and art of providing suitable substitutes for the coronal (crown) portions of teeth, or for one or more lost natural teeth and their associate parts, in order that impaired function, esthetic appearance, comfort and health of the patient may be restored."

While preventive dentistry has advanced considerably in recent years, the premature loss of teeth is still a major problem. Methods of tooth replacement include the fixed bridge, the removable partial denture, the full crown to restore the crown portion of the natural tooth, and the full denture to replace all the natural teeth in the arch. The fixed bridge is attached to the two teeth adjacent to the missing tooth or teeth. The abutment (attachment) teeth are prepared to receive some type of precision casting, usually in gold, which is cemented to the teeth. These attachments support the appliance restoring the missing teeth. This type of bridge cannot be readily removed by the patient or dentist. In the anterior region of the mouth, these gold abutments are usually covered with a baked porcelain crown, for cosmetic reasons. Plastic crowns are also used for this purpose. The removable partial denture is an appliance which rests on the soft tissue of the mouth. The natural teeth in the mouth may be used for retention and secondary support. This type of replacement can be easily removed by the patient. The full denture, replacing all the teeth in the dental arch, depends on some means of suction and on perfect conformity to the soft tissues of the mouth for its retention.

The type of replacement varies with the particular condition to be corrected. The materials used in the construction of prosthetic appliances include gold, acrylic resins, and steel alloy. The teeth may be made of baked porcelain, plastic, or metals. *See also* Comparative Anatomy; Dentistry; Mammals; Man, Functional Anatomy of; Mouth Diseases; Physical Growth. G. A. H.

**TEFILLIN.** *See* Tephillin.

**TEFLON.** *See* Plastics (*Commercial Plastics*).

**TEGNÉR, ESAIAS** [tɛŋne'r] (1782-1846), Swedish poet, was born in the province of Värmland, Nov. 13, 1782. When he was eleven years old his mother, the poverty-stricken widow of a clergyman, could no longer support him, and the district attorney let him serve as copy clerk in his office. Later he lived in the home of a wealthy family where his older brother was a tutor, and after three years of private study he entered the University of Lund. Even as a young student he read Latin, Greek, French, German, and English, and later he studied Old Norse. He graduated from the university in 1802, and for ten years was instructor and assistant professor in aesthetics there, receiving an appointment as professor of Greek in 1812. At that time he was already one of Sweden's well-known poets.

In his first literary efforts Tegnér was influenced by Swedish poets such as Carl Gustaf af Leopold, Johan Henrik Kellgren, Frans M. Franzén, and Bengt Linder, as well as by Ossian, Milton, and Edward Young in English literature, and especially by Schiller in German. He did not share the new Romantic School's interest in German philosophy, and his attitude was also negative toward French philosophy, which had inspired the old school; it was rather the political happenings of the time which gave him his best poetic inspiration. Russia's attack on Sweden and the conquest of Finland form the background of his poem, *Krigssång för skånska lantvärnet* (1808) ("War Song of the Militia"). His political feelings were still more strongly expressed in *Det eviga* (1810) ("The Eternal"); and in *Svea,* written in 1811, he found his forte. His contemporaries regarded *Svea* as a Swedish Marseillaise, and Tegnér became at once the great national poet of Sweden.

Having joined Götiska Förbundet, a society for the promotion of interest in Swedish antiquity and the ancient Norse ideals, Tegnér used old Norse themes for his poems. An Icelandic saga gave him material for an epic cycle, *Frithiofs saga* (1825) (English translation, *Frithiof's Saga,* 1924), often called Sweden's national epic. Some of Tegnér's poems from this period express his political ideas; in others he used historical themes, as in *Karl XII* (1818) and *Axel* (1822). The idyl *Nattvardsbarnen,* written in hexameters, was published in 1820 (English translation, 1841, by H. W. Longfellow: *The Children of the Lord's Supper*). After his appointment as bishop he devoted less time than before to poetry; he suffered from melancholia, and for a time was forced to seek care in a hospital for the insane. After his recovery he wrote another idyl in hexameter, *Kronbruden* (1841) ("The Crowned Bride"). Tegnér was not only one

of Sweden's greatest poets; he was unsurpassed as an orator and writer of letters. He died Nov. 2, 1845, at Växjö. His collected works were published in Stockholm in 1918-1925 in 10 volumes. A. Wi.

**TEGUCIGALPA** [tegu'sigɑ'lpɑ], the capital of the Central American republic of Honduras, situated on the upper courses of the Choluteca River, about 62 mi. from the Pacific seaboard city of San Lorenzo. It is attractively located on an interior plateau, 3,200 ft. above sea level and completely surrounded by heavily forested mountains. There are no land routes to or from Tegucigalpa except a highway to San Lorenzo on the south and to Potrerillos on the north. However, the city is well served by an efficient air-line system which links it with other Honduran cities and with other countries. The surrounding hills and valleys are rich in gold and silver, and the mining of these minerals is a leading occupation. Shirt making and beverage bottling are the principal industries. The city, founded in 1578, became the capital of Honduras in 1880. Pop. 1950, 72,385. S. G. I.

**TEHRAN** or **TEHERAN** [tɛrɑ'n, tɛhərɑ'n], the capital of Iran, located in the foothills of the lofty Elburz Mountains, 70 mi. south of the Caspian Sea. The 12,000-ft. range somewhat isolates the city geographically, presenting a serious water-supply problem and providing Tehran with extremely hot summers. Although mentioned by the Arab geographer Yaqut, in the twelfth century, Tehran was not well known until the eighteenth century, when it was selected as the capital city. The Iranian rulers had moved their capital often over the course of centuries, locating it variously in Tabriz, Isfahan, Kazvin, and other cities. Tehran was made the capital by Agha Mohammed Khan, founder of the Kajar Dynasty, in 1785. The choice was dictated for the most part by its central location at the northern extremity of the Iranian plateau and the proximity of the tribes from which the Kajar Dynasty had originated, as well as by the fact that it lies at the conjunction of roads and trade routes from many directions. The city is about 25 mi. from the nearest river or waterway and water is scarce. Because of the city's torrid summers, a large proportion of Tehran's residents desert the city for cooler, suburban Shimran, a series of some sixty villages on the lower slopes of the Elburz Mountains. Improved roads connect Tehran with all major cities, and the Trans-Iranian Railway, opened by the Shah on Aug. 26, 1938, connects Bandar Shah on the Caspian Sea with Bandar Shahpur on the Persian Gulf. During World War II, the railway served as a vital matériel supply route for American lend-lease equipment en route to the Soviet Union. International air lines link Tehran with the major cities of Africa, Asia, Europe, and the United States.

Produce from the surrounding region is brought to Tehran, which has a modern grain elevator of large capacity as well as sugar and cement factories in the vicinity. It is also a center for the country's large textile industry and contains mills for the ginning, spinning, and weaving of cotton and the spinning and weaving of wool. The export of woolen rugs, primarily to the United States and the United Kingdom, is a leading economic activity. Pop. 1950, 989,871. J. C. Wi.

*Marshal Joseph Stalin, President Franklin D. Roosevelt, and Prime Minister Winston Churchill relax during an intermission of the 1943 conference held at Tehran.*

EWING GALLOWAY

**TEHRAN, UNIVERSITY OF,** a coeducational university, which was established by Mirza Taghi Kham Amir Kabir in Tehran, Iran, in 1934. To form Iran's first modern university, several schools of higher learning which already existed in the nation's capital were merged. These united institutions introduced modern European educational ideas and methods, and the law of 1934, which created the university, also provided for its financial and administrative independence. In 1942 the university became independent of the government, and in 1944 the Shah gave the village of Amerabad and its buildings to the university to use as a self-contained students' club and hostel and as a university center. Tehran University consists of six faculties, four affiliated schools, and the hospitals of Tehran. The faculties are: literature, philosophy, and pedagogy; law, economics, and political sciences; medicine, pharmacy, and dentistry; engineering; theology; and science. The schools affiliated with the university are the School of Arts, the Veterinary College, the Agricultural College, and the National Teachers College. The enrollment for all schools averages nearly 5,000. A.L.H-Q.

**TEHRAN CONFERENCE,** a wartime meeting of the top Allied leaders, held at Tehran, Iran, between Nov. 28 and Dec. 1, 1943. This conference was preceded by a meeting in Cairo, Egypt (Nov. 22-26, 1943) of President Franklin D. Roosevelt, Prime Minister Winston Churchill, and Generalissimo Chiang Kai-shek, at which plans were discussed for the vigorous pursuit of the war on Japan. The meeting was also a tacit admission of China to "Big Four" status. From Cairo, President Roosevelt and Prime Minister Churchill flew directly to Tehran, where they conferred with Marshal Joseph Stalin and allied military leaders on war strategy and international affairs. The invasion of Europe was planned and a tentative date decided upon. Immediately following the conference, Gen. Dwight Eisenhower was sent to London as Supreme Commander of the Allied forces to commence preparations for the assault on Europe. It was President Roosevelt's first meeting with Marshal Stalin and also the first discussion by the "Big Three" of the President's proposals for a United Nations organization. C. W. D.

**TEJU** [tɛyu'], any of several edible South American lizards of the genus *Tupinambis,* the largest (4 ft. over-all) representatives of the family Teiidae. Tejus are waxy black above, cross-banded, splotched, or sprinkled with yellow or white. Their bodies are flattened, rather than compressed, relatively stockier than those of iguanas, and have no spines. These aggressive lizards are truly omnivorous; they eat eggs, carrion, fruits, berries, chickens, rats, and other animals. Fast-running ground dwellers, they also dig well and climb to

the lower branches of trees. Their eggs have been found in termite nests. M. G. N.

**TELAMON** [tɛ′ləmɒn], in Greek legend, king of Salamis, son of Aeacus, and brother of Peleus. By Periboea he became father of Ajax. He took part in the Calydonian hunt, the Argonautic expedition, and the expedition of Heracles against Laomedon of Troy. Upon the capture of the city, Heracles gave Hesione to Telamon, and the son of this union was Teucer. G. E. D.

**TELAUTOGRAPH SYSTEMS.** *See* TELEGRAPHY (*Teletype Systems*).

**TEL AVIV** [tɛ′l əvi′v], officially Tel Aviv-Jaffa, the largest city of the state of Israel, located on the coast of the Mediterranean Sea, about 50 mi. southwest of Haifa and 35 mi. northwest of Jerusalem. It is on the low Plain of Sharon, irrigated only by two small rivers, of which only one, the Yarkom, supplies water during the arid summer season. However, despite this geographical difficulty and the handicap of a poor harbor, necessitating a lighterage to unload ships of large size, Tel Aviv has had a mushroom growth since its founding in 1909, and is now a modern city, the center of Israel's cultural and economic activity.

Tel Aviv was founded as a suburb of nearby Jaffa, and is in sharp contrast to the congested, oriental character of the older city, which has flourished since the fifteenth century, B.C. The rapid expansion and growth of the "suburb" soon covered the distance between the two cities. In 1921 Tel Aviv became a municipality dependent upon Jaffa; in 1934 it was made an independent municipality; and in 1950 the two cities were amalgamated by the Israel government. Although near the area of heavy fighting in the Israeli-Arab War, the city was not seriously damaged.

The surrounding countryside has been developed for agricultural purposes with the aid of modern irrigation methods, and wheat, vegetables, citrus fruits, olives, and melons are grown in abundance. Some sheep and goats are raised and fishing is a local industry. In addition, the plentiful supply of limestone and cement has helped immeasurably in the building of the city. Tel Aviv is also the center of the country's financial activities, and since the opening of the port in 1936 its shipping industry has become important. The commerce and industry are centered in the southern part of Tel Aviv, while the northern part has become a fine modern residential area. The city is also the seat of various national organizations and institutions, such as the Histadrut (trade unions), the Opera, the Israel Philharmonic Orchestra, and theaters. Pop. 1951, 340,000. D. H. K.-A.

**TELEGRAPHIC CODE.** *See* CODE; TELEGRAPHY.

**TELEGRAPH PLANT,** or semaphore plant, an East Indian perennial tick trefoil, *Desmodium gyrans,* belonging to the pea family. It is sometimes grown as a curiosity because of the movements of the small lateral leaflets of the trifoliate leaves. In daylight, when the air is moist and warmer than 72° F., the leaflets jerk up and down every few minutes like the arms of a semaphore. At night, the leaves droop down as if asleep. This plant grows about 4 ft. tall. *See also* SENSITIVE PLANT. E. R. C.

**TELEGRAPHY** [təlɛ′grəfi], a system of communication between two or more points in which electric impulses are transmitted and received as signals in accordance with a code. The term "telegraphy" means "far-off writing." Originally, the term was applied to semaphores and other visible manually operated systems, but in modern usage it applies only to a system employing electrical apparatus.

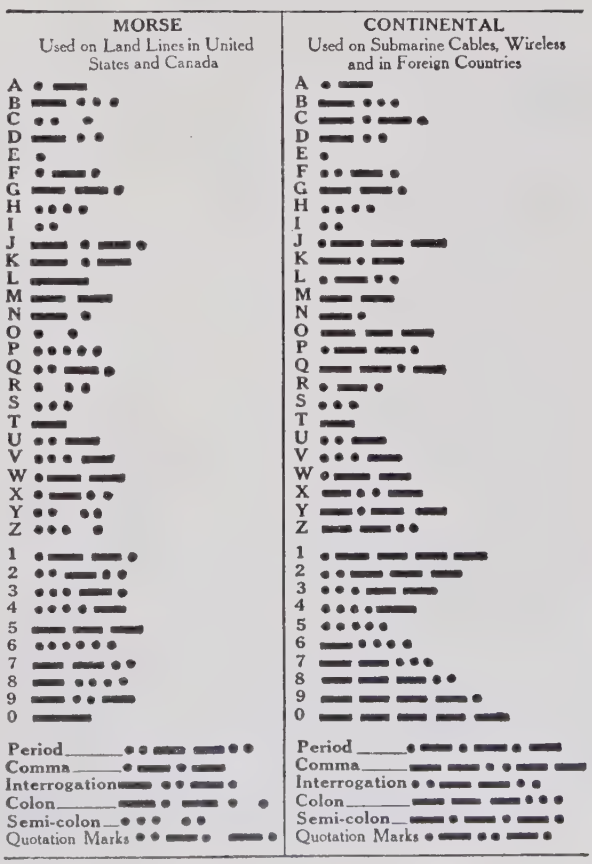
### WIRE SYSTEMS

In 1838 Samuel F. B. Morse demonstrated a model of his telegraph before the Franklin Institute, and, in 1844, upon receiving an appropriation from Congress, he built a line between Baltimore and Washington. It consisted of a key (switch) and electromagnet (sounder) at each end, in series with a wire and a battery; the earth acted as the return line. Either key sent a series of impulses, in the form of a prearranged code representing the various letters of the alphabet, to energize the sounder at the other end of the wire. A number of telegraph companies were founded thereafter, some licensed under Morse's patents and others employing a printing type of telegraph. These were all ultimately merged into the Western Union Company. In the meantime, cables were laid across the Atlantic by Cyrus W. Field, and others, the first permanent one being laid in 1866.

Since that time there have been evolved two-way (duplex) and four-way (quadruplex) transmission on a single line, multiplex, Varioplex, carrier telegraphy, Desk-fax, and microwave radio relay links. Indeed, telegraphy has advanced more rapidly in recent years than when first developed.

**Telegraph Codes.** In the Morse code used on manually operated lines in the United States, and the Continental code, used by foreign countries and universally in radio telegraphy, a short pulse is known as a dot, and a pulse three times as long is known as a dash. These, in combination with the intervening spaces, form the codes illustrated.

TELEGRAPH CODES


MORSE
Used on Land Lines in United States and Canada
CONTINENTAL
Used on Submarine Cables, Wireless and in Foreign Countries
A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
1 2 3 4 5 6 7 8 9 0
Period
Comma
Interrogation
Colon
Semi-colon
Quotation Marks

In the Morse cable code, dots and dashes are of equal length but of opposite polarity, in order to secure a better transient response with a minimum of voltage stress of the dielectric of a long cable. For multiplex, and start-stop printing systems, a series of five equal intervals is used to represent each character; the sequence of used and unused intervals determines the letter.

**Instruments.** The two basic instruments of the Morse system are the sending key and the sounder (Fig. 1). The auxiliary switch maintains a closed circuit by shunting the key contacts when the other end of the wire is sending, and must be opened when transmitting. The sounder magnet,

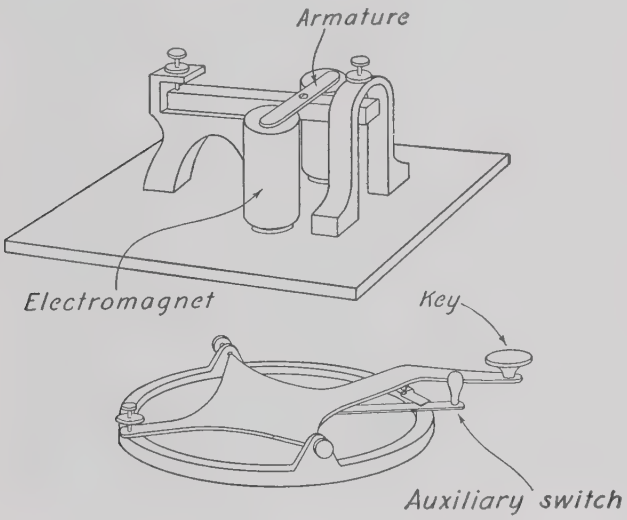



*Fig. 1—Basic instruments of the Morse system: sounder (above) and sending key (below)*

when energized, attracts the armature, which clicks when pulled down and when released. A relay is a sensitive sounder with auxiliary contacts in series with the next portion of the line and a battery. When actuated by incoming pulses, the relay sends similar stronger pulses down the next line. It has been supplanted by repeater amplifiers and is now used only in a printer mechanism.

A multiplex distributor is a rotating switch or commutator that successively switches different telegraph transmitters into a common line. A similar synchronously rotating switch at the receiving end reswitches the incoming pulses to the different printers corresponding to the transmitters. The various transmitters are thus sampled momentarily for their dots and dashes, similar to pulse modulation, and the line can handle a number of messages, while the terminal equipment operates at normal speed. The pulses are lengthened at the receiving end to their normal dot or dash duration. The transmitters send the pulses direct or via perforated tape punched out on a special typewriter. The receivers are essentially typewriters without keyboards, although in the start-stop system the machine can function as a transmitter or receiver.

The Varioplex mechanism switches a large number of intermittent services or subgroups into a multiplex system. The operating speed varies inversely as the number of services added, but owing to the diversity factor, the system is seldom slowed down to a relatively low speed. Thus, the lines are operated at a high load factor, yet each customer has a private channel available at all times.

Another recent development is the customer-switching system of Western Union. A coded set of perforations precedes each message on the tape and serves to route the message automatically from the transmitting end to the main station nearest its destination. From here, it is sent to its final destination (branch office) by push-button selection. Reperforating machines enable the rerouting to be made by an operator pushing the proper button on a switchboard to select the proper outgoing circuit.

Desk-fax is a facsimile system employing a scanning light in the transmitter, located on the premises of large custom-

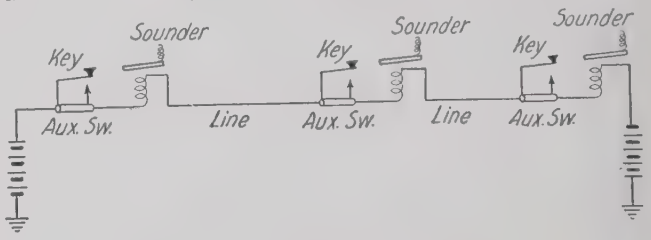



*Fig. 2—MORSE SIMPLEX SYSTEM*

ers, and a reproducing machine at the central station. The sender places his message around the transmitting drum and pushes a button. This signals the central station operator, who plugs in his receiver, and transmission starts. A special impregnated paper (Teledeltos) turns black when current passes through it, thus reproducing the original message; this can then be scanned for retransmission. The operator signals the recipient, who places a Teledeltos blank in his machine and presses a button to start his recorder; the original message is thus delivered electrically to him.

**D.-C. Telegraph Systems.** There are a large number of d.-c. telegraph circuits and systems, of which the simplex and the duplex are the two basic types. In the simplex system (Fig. 2) all components are in series; to send, the auxiliary switch is opened and the key manipulated.

In the duplex system messages can be sent simultaneously

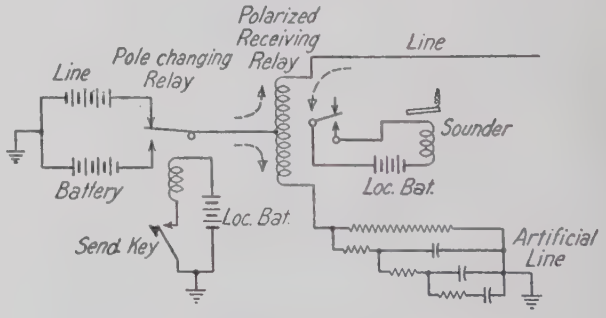



*Fig. 3—DIFFERENTIAL POLAR DUPLEX SYSTEM*

in both directions. The preferred method (Fig. 3) employs current reversal and polarized relays for reliability. The outgoing current divides equally and oppositely between the two halves of the polarized receiving relay, for equal impedances of the artificial and actual lines, and the relay does not operate; but incoming currents flow through its two half windings in series, causing it to actuate the sounder.

**A.-C. Telegraph Systems.** The a.-c. telegraph system employs carrier frequencies, each modulated (turned on and off) by the code. Two-wire lines are required, but a much greater number of services can be handled. A total band width of 36 kc. is subdivided into four carriers (Fig. 4), with each divided into two "voice" bands approximately 3600 c.p.s. wide. A voice band can accommodate a telephone conversation, or a Desk-fax message, or four high-speed busi-

ness machine services, or nine four-channel multiplex or Varioplex channels, or sixteen teleprinter channels.

Frequency modulation is used for superior signal-to-noise characteristics. A frequency deviation in one direction represents a dot; a deviation in the opposite direction represents a dash. Teleprinter channels employ a deviation of ±35 c.p.s., whereas multiplex and Varioplex channels are deviated ±70 c.p.s. Filters are employed to separate the various channels, and limiters serve to improve the signal-to-noise ratio. A discriminator then demodulates the carrier signal in a manner similar to that of a frequency modulation receiver.

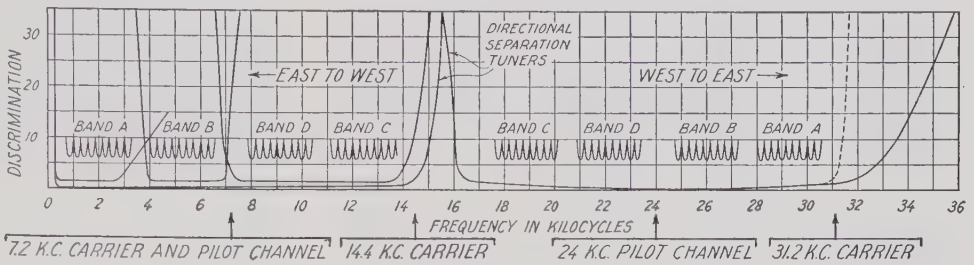



*Fig. 4—G-1 CARRIER SYSTEM*

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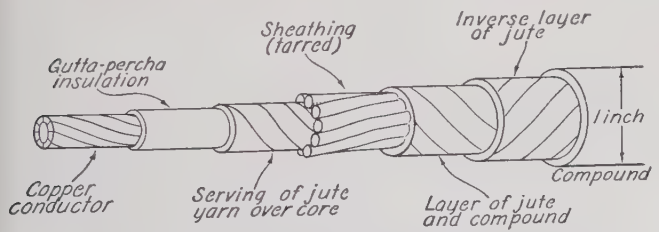
## TELEGRAPH CABLES

**Local Cables. Mechanical Features.** Cables are lead-sheathed and use No. 16 American wire gauge (0.058 in.), or larger, for trunks, with paper insulation designed to withstand a 1,200-volt breakdown test. The wires are paired and usually quadded. Local cables for cities and towns employ No. 19 A.W.G. (0.042 in.) and are insulated for 500 volts. Special precautionary devices, such as pilot wires and electronic means, are used to minimize inductive interference from power lines. Cables are run aerially wherever possible, though in congested areas they are run in underground conduits. They are generally routed along a railroad right of way as, historically, railroads were the largest telegraph users.




COURTESY AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

*Fig. 5—NONLOADED CABLE CONSTRUCTION*

**Submarine Cables.** The submarine nonloaded cable, shown in Fig. 5, has a single copper conductor, usually stranded for flexibility. The principal insulation is a thick core of gutta-percha. This is protected against mechanical injury by jute yarn and a steel-armor wire sheathing, as shown. For shallow water, the cables have additional armor and jute protection against abrasion from wave action and anchors. For ocean cables, an additional wire is included out into the deep sea to act as an extension of ground for the terminal equipment. This wire obviates the use of a land ground for the equipment, with the attendant disturbances.

**Loaded Cables.** The ordinary cable, especially if as long as 3,500 mi., has excessive capacitance and insufficient inductance. As a result, very high attenuation and phase distortion exist. In order to obviate this inherent disadvantage, signals of opposite polarity but equal duration have been employed for the dots and dashes; and in order to prevent insulation breakdown, low voltages have been employed. This system necessitated the use of very sensitive syphon recorders, which printed the message on paper tape.

In 1924 Western Union introduced the uniformly loaded cable. This employed a wafer-thin permalloy metal tape wrapped around the single copper conductor. Permalloy, in contrast to ordinary iron, has a very high permeability for low magnetomotive forces and, hence, can add appreciable inductance to a conductor even when weak telegraph currents flow through it. The increase in inductance compensates for the high capacitance, and permits a modern cable to transmit a total number of words equal to that of seven nonloaded cables. By means of multichannel operation, eight individual messages are transmitted simultaneously at a rate of 2,800 letters per minute.

## RADIOTELEGRAPHY

**Systems of Transmission.** Both long and short waves are used for transmission of radiotelegraphy. Long waves are reliable both day and night; they traverse the space between the earth and ionosphere for any distance, but require large amounts of power. Short waves are efficiently reflected from the ionosphere to distant points of the earth (skip distance) and require much less power. However, owing to variation of the layers of the ionosphere, especially after sundown, different frequencies are required for day and night operation, and transmission is not as reliable as by long waves. The carrier may simply be keyed on or off (continuous wave telegraphy), or the carrier may be modulated with an audio tone or continuous wave (interrupted continuous wave). A more recent development is carrier shift: the carrier frequency is shifted by a suitable amount from its normal value to represent dots and dashes. This system gives a higher signal-to-noise ratio and is becoming increasingly popular.

**Signaling Speeds.** High signaling speeds are possible because of the relatively large band width possible with a radio carrier. Transmission from a central office is by autoheads, which transmit the five-element signals punched on a paper tape. Such signals are readily multiplexed to afford speeds as high as 200 words per minute, even though the operators, or printers (if used), receive the individual messages at only 60 words per minute.

In 1945, Western Union inaugurated an ultra-high-frequency (u.h.f.) radio link, operating at 4,000 megacycles, and higher, and transmitting a number of messages at high speed. This link consists of transmitter-receiver stations separated by as much as 55 miles. Klystron tubes are used as generators of the u.h.f. power, and radiation is from a wave guide and parabolic reflector, having a gain of 28 decibels (db.) over a dipole. Double-frequency modulation is employed: a 1-mc. subcarrier is frequency-modulated with as many as 32 voice bands, and the resulting 150-kc. band frequency-modulates the radiated carrier. In this way, the distortion for several repeaters is kept down to a satisfactorily low level.

**Radio Interference.** Atmospheric static is a major source

of interference for long waves; of fading, for short waves. The use of an audio tone enables an experienced operator to receive signals even weaker than static, and diversity reception minimizes fading. It has been found that a short wave will fade at different times at two different locations, hence, several receiving antennas and sets actuated by a common automatic volume control (a.v.c.), and connected to a common output, reduce this difficulty. Transmission on two slightly different frequencies to a common receiver (diversity-frequency reception) also reduces fading. Also, adequate frequency separation and elimination of key "clicks" (transients) help to eliminate interference.

### TELETYPE SYSTEMS

**Start-stop Printing System.** A teletype printer is a device for printing messages at a point remote from the transmitting machine. In the start-stop printing system, seven pulses are used per character: a "start" signal, five intervals for the character (see Telegraph Codes, above) and a "stop" signal. Special typewriters are employed; these have a three-row keyboard (Fig. 6), and print only capital letters, punctuation marks, and numerals. Each has a continuously revolving slipping clutch; all clutches operate at approximately the same speed.

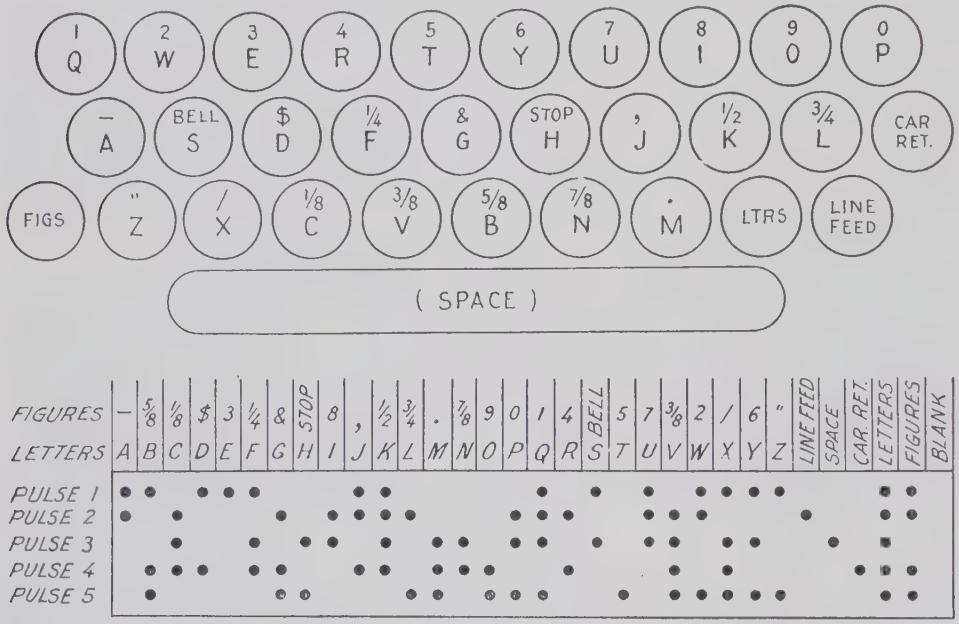



*Fig. 6—TWX KEYBOARD AND FIVE-UNIT TWX CODE*

The start pulse on each machine unlatches a movable contact arm on a rotary switch having seven segments. All contact arms are then rotated at the same speed through one revolution by the slipping clutches, when the stop pulse of the transmitting machine latches the switches at the receiving machines. Thus, the two synchronizing pulses, start and stop, obviate the need for ultraprecise speed control of the driving motor at each machine. Each type key at the transmitter, when struck, sends out dots and spaces in the five-interval period between the start and stop; the appropriate keys at the receiving teletypewriters respond accordingly. Tape and page machines can be employed simultaneously; additional signals shift the carriage or keys (depending upon the machine), and raise or lower the carriage.

**Intercommunicating Teletype Systems.** Any machine can be used as a transmitter or receiver. The typing speed is 65 words per minute, and carbon copies are possible. Connections are made as in ordinary telegraphy or telephony through switchboards, and multiplex and Varioplex operation can be employed. Regenerative repeaters that reshape the received distorted signal permit operation over any distance, and normal line distortions as high as 40 per cent in the timing of the received signal do not require synchronization of the motor speeds better than $\pm$ 75 per cent, owing to the use of start and stop pulses.

**Telautograph Systems.** The telautograph, invented by Elisha Gray, permits transmission of handwriting, sketches, and the like. It is used in electric generating stations, railroad terminals, factories, and anywhere else a written record of the message is desired. As illustrated in Fig. 7, the sending stylus is connected by arms to two rheostats. Any motion of the stylus on the platen causes corresponding variations in the setting of the two rheostat arms. Connecting wires transmit the current variations produced to a pair of bucket coils, each set in a magnet structure somewhat like a dynamic loud-speaker coil. These bucket coils are connected to a receiving stylus by a linkage similar to that at the transmitter. As the buckets move up and down, they cause the receiving stylus to follow the transmitting stylus and thus trace on a roll of paper the message sent. A receiving unit at the transmitter end enables the operator to see the message he is sending. It will be observed that two wires and a ground return

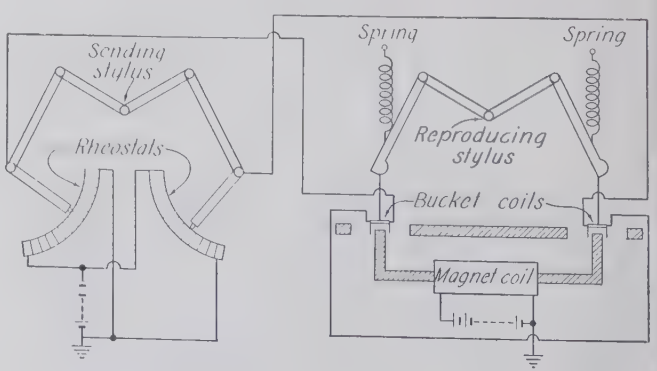



*Fig. 7—Simplified schematic diagram of a telautograph system*

are required. By the use of superimposed alternating current, the additional motions of shifting the paper and lifting the pen off the paper, as well as signaling, are obtained. *See also* FACSIMILE. A. Pr.

**TEL EL-AMARNA.** *See* TELL EL-AMARNA.

**TELEMACHUS** [təlɛ′məkəs], in Greek legend, the son of Odysseus and Penelope. He was an infant when his father went to Troy, and, when almost twenty years had elapsed, Telemachus went to Pylos and Sparta to enquire about him; on his return to Ithaca he found Odysseus already at home, but disguised as a beggar, and Telemachus assisted him in slaying Penelope's suitors. In a post-Homeric legend, Telemachus later became the husband of Circe, or of Cassiphone, Circe's daughter. *See also* ODYSSEUS; ODYSSEY, THE. G. E. D.

**TELEMANN, GEORG PHILIPP** [te′ləmɑn] (1681-1767), German composer, was born on Mar. 14, 1681, in Magdeburg. Appointed music director of the largest church in Hamburg in 1721, he became a prominent representative of the Hamburg school of composers. Although he was an extremely prolific composer, he contributed little to the advancement of the music of his time. He composed at least forty operas, forty-four Passions, thirty-two installation services, twenty ordination services, and numerous oratorios, as well as some six hundred overtures in the French style and a mass of vocal and instrumental music of all kinds. He died in Hamburg, June 25, 1767. D. L. E.

**TELEMETERING.** *See* MEASUREMENTS, ELECTRICAL.
**TELENGUT.** *See* ASIATIC TRIBES (*Turkic*).

**TELEOLOGY** [ti′liɒ′loji], from the Greek word τέλος, meaning end or goal, is the doctrine that the world as a whole or certain events in the world fulfill some end or purpose. Aristotle's philosophy is teleological because he believed that things aim at the realization of their proper nature or essence. The potentialities of matter develop into the actual things of this world because they are motivated by the perfection that would be achieved thereby. Consequently, among the causes that explain the development of a thing must be included its "final cause," the end for the sake of which it exists, or the value which is its reason for being.

A teleological explanation differs from a mechanical one in that the latter accounts for what happens by immediately preceding conditions: e.g., a baseball moves the way it does because it has just been struck by a bat; whereas a teleological explanation accounts for what happens by referring to a goal yet to be achieved—e.g., the motion of the ball could be explained as the result of the batter's aim.

It is a debated issue whether teleological concepts such as purpose are needed in the biological sciences. The fact that living things possess organs adapted to the environment and able to function so as to serve the ends of the whole organism does not necessarily prove that the ends were the cause, either conscious or unconscious, of the development of those organs.

Insofar as conscious intent or design is involved, teleology becomes synonymous with purposiveness. It is on this ground that some thinkers maintain that teleological explanations are relevant and legitimate only for the behavior of human beings and perhaps some of the higher animals that are capable of conscious purposes. Galileo was rejecting teleology when he argued that the way to find out whether there are satellites revolving about the planet Jupiter is to look through a telescope, not, as some learned scholars maintained, to discuss whether such satellites would serve any purpose.

In ethics a theory is said to be teleological when the moral rules of conduct it enjoins are justified by the value of the ends to which the conduct leads or is intended to lead. Such a theory is distinguished from one in which the moral worth of conduct is not determined by the value of the ends.

In religion one of the best known arguments for the existence of God is a teleological argument. A purely mechanistic account of the world is said to be inadequate to explain the order in nature and the adaptation of part to part. From this it is concluded that the world must be the product of a designing Providence or God. The English theologian William Paley (1743-1805) argued that, just as a watch whose parts fit nicely together presupposes a watchmaker who aimed at producing a mechanism to keep time, so an orderly world presupposes a divine Author who created the world because he saw that it would be good. The purposiveness that nature seems to exhibit is not, then, to be sought in nature itself by scientific methods; it is to be attributed to a transcendent Being.

The philosopher Kant maintained that neither the apparent design of the world as a whole, nor of organisms within the world, can be explained mechanically from knowledge of the constituent elements. Nevertheless, he rejected the teleological argument for God and argued that, whatever may be the limitations of a mechanical explanation for living things, the concept of purpose cannot be legitimately applied in natural science. A. G. R.

**TELEPATHY.** *See* PSYCHICAL RESEARCH OR PARAPSYCHOLOGY.

**TELEPHONY** [təlɛ′foni], an electrical system for transmitting sound. A transmitter transduces the sound into electrical currents; these are transmitted by conductors to a receiver, which reconverts the currents into sound, once more. The telephone is a telegraph system in which a transmitter (microphone) and receiver replace, respectively, the telegraph key and sounder.

### THE TELEPHONE

In 1876, Alexander Graham Bell received a patent for a practical electrical telephone. As shown in Fig. 1, sound waves vibrate the transmitter diaphragm, thereby varying the air gap and magnetic flux. The latter induces a corresponding voltage in the two coils, causing a current to flow

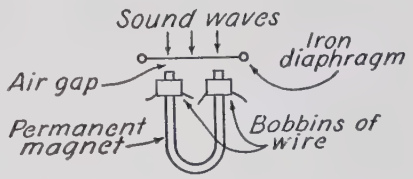



*Fig. 1 — Principle of operation of first practical telephone*

through them and then through the bobbins of a similar receiver unit connected to the transmitter by a pair of wires. The varying current produces flux variations in the receiver, and causes its diaphragm to vibrate and set the adjacent air in motion, thus reproducing the sound waves.

In 1878 David Edward Hughes, among others, invented a microphone type of transmitter, which produced more electrical energy from a local battery than the impinging sound energy; Fig. 2 shows a more modern form. The vibrating diaphragm varies the electrical resistance between the carbon contacts, producing a much larger varying current than the

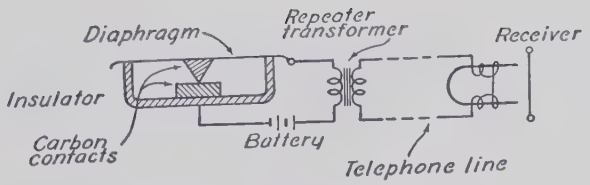



*Fig. 2—Principle of operation of a more modern form of telephone*

original Bell transmitter. This microphone, although irreversible, is a kind of amplifier and actuates the receiver very strongly. Modern units employ carbon granules as a plurality of microphone contacts actuated by the diaphragm to give still greater output; and this, in conjunction with series inductances (loading coils) to decrease the high-frequency losses, and the use of vacuum-tube (repeater) amplifiers, has served to extend transmission clear across the continent.

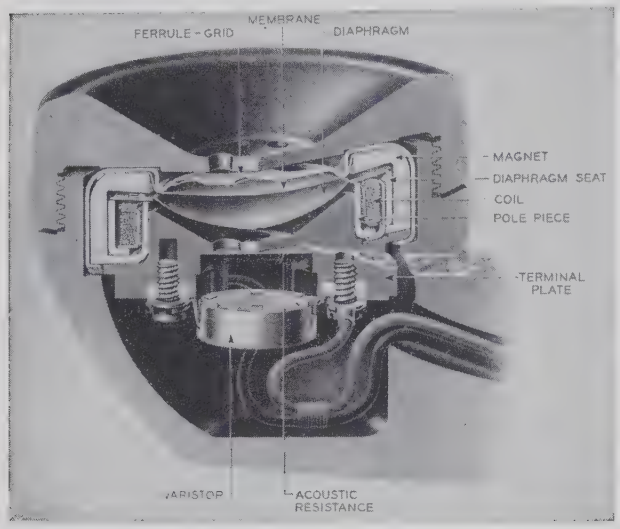



*Fig. 3(a)—Sectional view of the ring armature receiver in a handset*

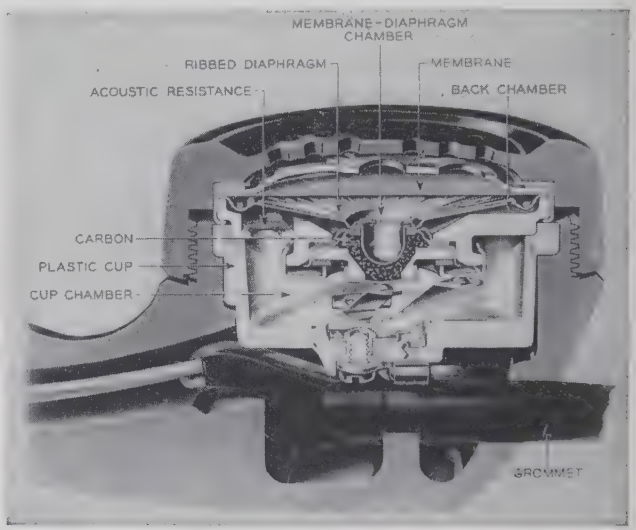



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*Fig. 3(b)—Sectional view of the transmitter in a handset*

**Telephone Transmitters and Receivers.** A modern handset contains the receiver (Fig. 3*a*) and transmitter (Fig. 3*b*) in one housing. The transmitter diaphragm is clamped rigidly at its periphery to enhance the high-frequency response, and is coupled to a doubly resonant system consisting of a cavity and chamber to broaden the response. The carbon chamber contains the carbon granules the contact resistance of which is varied by the vibration of a diaphragm. The receiver consists of an annular magnet system enclosing a coil, and an iron ring armature caused to vibrate in the air gap by the current in the coil. An attached phenolic-impregnated fabric diaphragm, in the shape of a dome, vibrates and sets the air in motion in the canal of the ear. Both units are about 5 decibels more efficient than the handset they supersede.

**Substation Circuits.** A common battery in the central office energizes the handsets in the various substations. Fig. 4 shows a common-battery anti-sidetone dial-type set, or substation. When the handset is picked up, one of the switch contacts disconnects the ringer and connects line $L_2$ to the handset, while the other switch contact connects $L_1$. The third switch contact opens and unshorts the receiver. When the dial is actuated, contact $A$ momentarily shorts the receiver, while contact $B$ pulses the line in accordance with the number dialed. The filament heats up in inverse manner to the length of the connected loop or line, and the thermistor's resistance varies inversely as the filament's temperature to which it is thermally coupled. It thus shunts the receiver less on a longer loop, allowing the receiver sensitivity to increase to compensate for the longer loop. The varistors act as protective shunts. The anti-sidetone circuit consists of the induction coil having primary, secondary, and tertiary windings, as well as a balancing impedance to maintain the action over a wider frequency range. This circuit minimizes the audio currents in the receiver from its own transmitter, thereby permitting the subscriber (telephone user) to speak louder. It also prevents the room noise picked up by the transmitter from masking the incoming signal in the receiver.

**System Layout.** The subscribers' substations, in general, are connected by individual pairs of wires to a control station, or exchange. Here, connections between associated substations, or between two substations of different exchanges, can be made either manually or automatically (dial system); the latter system predominates today. The dial system employs either the step-by-step mechanism, for small exchanges; the panel system, for the larger exchanges; or the

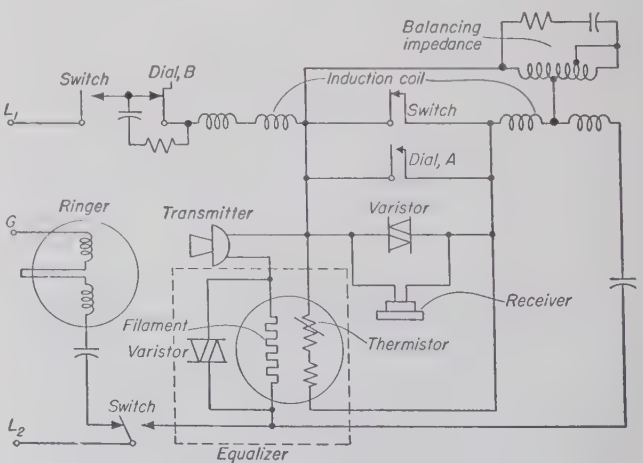


*Fig. 4—Common-battery anti-sidetone dial-type set, or substation*

crossbar system, more recently developed as an improvement over the panel system.

The subscribers to an exchange, and the lines in it, are divided into groups. In the step-by-step system, an idle "line-finder" switch locates the caller's line in his group, connects it to a selector, and is then disconnected to handle other incoming calls. The selector gives the subscriber the dial tone, and he starts dialing. The dial impulses actuate the selector to choose a certain group of lines in the exchange, and then an idle one from these. Further dial impulses from the succeeding numbers dialed cause other selectors to choose an idle line in another subgroup, or idle trunk to another exchange, as required. This action proceeds, step-by-step, until the last two numbers cause a final selector (a multibank switch called a connector) to choose the proper bank or level in which the called subscriber is connected in common with others in his group, and then to rotate the connector across the contacts of this switch bank to those of the desired subscriber. If he is free, the call is completed; if his line is busy, connections are made to the busy signal, instead.

In the panel and crossbar systems, the numbers are stored in a "sender" group of relays. The sender actuates other switches, which send revertive pulses back to the sender and stop on contacts when their pulses equal those dialed to the sender. Connections are thus controlled by the dialing subscriber, but are made independently of his speed of dialing.

*Nationwide Automatic Switching.* The nationwide system of automatic switching calls for a system of switching points: a National Center (NC), at St. Louis; nine Regional Centers (RC), including Canada; Sectional-Centers (SC), that handle a section of a region; Primary and Tandem Outlets (PO) and (TO), that handle parts of a section; and Toll Centers (TC), that serve a cluster of nearby tributary points in a PO or TO.

In dialing a long distance call, as many as eight intertoll trunks may be involved in tandem, all connected at switching points. Normally, a minimum number of "high-usage" trunks, which avoid intermediate switching points, are used: but if these are all busy, "final" trunks between switching centers are automatically substituted.

Although operator toll dialing is intended at the start, ultimately, direct customer dialing is contemplated. A typical number will be 601-CA3, 4567, of which the first three numbers will indicate the area of the country; the next two letters and number, the office; and the remaining four, the substation (subscriber). For calls in the same area, the first three letters will be omitted. To handle this operation, a very complicated switching system incorporating punched metal cards, an optical system, and phototransistors, have been developed as a part of a so-called translator, used in conjunction with crossbar switches, senders, markers, and decoders.

**Carrier Telephony.** In order to transmit several messages on one pair of wires, a method similar to radio broadcasting is employed: each message is used to modulate a different high-frequency wave, known as a carrier. At the receiving end, special band-pass filters sort out the different carriers, demodulate them, and impress them upon the corresponding receivers. Suppose a 100-cycle speech component amplitude-modulates a 30,000-cycle carrier. The result is three frequencies: 30,000 c.p.s.; $30{,}000 - 100 = 29{,}900$ c.p.s.; and $30{,}000 + 100 = 30{,}100$ c.p.s. The last two are the lower and upper sidebands, respectively. It is possible to suppress either of these and still retain the 100-cycle intelligence; even the carrier can be suppressed and reinserted locally at the receiving end. Suppressing one set of sidebands is called single-sideband transmission, and halves the bandwidth required.

Carrier transmission is superior to that of the audio frequencies, alone, and permits a large number of channels on a given pair of wires or other service. For example, the N-carrier system, used on cables for short distances (15 to 200 mi.), has twelve channels. Type O carrier is used on open wire lines, and Type L carrier on coaxial cables; a pair of coaxial cables accommodates 600 channels (two-way transmission). Moreover, one repeater amplifier at each point in the line can amplify the entire group of modulated carriers, instead of merely one audio band. Although the terminal equipment is complicated and expensive, carrier telephony is employed even for short distances, as well as for long distances.

**Interference, Cross Talk.** All communication systems suffer from interfering signals originating in other equipment or in other channels. Telephone lines are often strung parallel to the right of way of power lines, if not on the same towers, and pick up energy from the power line either through inductive or capacitive coupling. Also, one pair of telephone wires may induce currents in another, or different modulated carriers may insert some of their intelligence on one another via nonlinear circuit elements (cross modulation). The last two types of interference are known as cross talk. Other sources of interference are the random thermal-noise voltages in resistors and shot-effect noise of the vacuum tubes used in the repeater amplifiers, as well as carbon hiss from the granules in the transmitter.

Power-line and cross-talk interference can be minimized by using metallic conductors for both sides of the circuit, instead of ground return, so that the impedances from each side of the line to ground are equal (balanced-to-ground). Also, reversing the conductors periodically and interchanging the positions of the lines on the pole lines or cables (transposition) helps to balance out the interfering signals. In addition, the energy level of the signal must not exceed certain practical values, such as 20 decibels (0.06 watt), in order to keep the cross talk down to a manageable level.

## TELEPHONE LINES

**Subscribers' Lines.** Paper is the usual insulation used for the copper-wire lines; in the Bell System, it is in the form of paper pulp over each conductor. A line may consist of two wires twisted together for the purpose of transposition to reduce pickup of extraneous signals; or two twisted pairs may be twisted together to form a quad, in order to furnish two metallic side circuits plus one phantom circuit. Groups of 100 pairs, or multiples thereof, form a cable; the group can be a mixture of pairs and quads of various sizes. A cable can have as many as 21 groups (2,100 pairs).

**Toll Lines and Cables; Mechanical Features.** Telephone lines may be in the form of tinned copper rubber-covered overhead wires (No. 22, 19, or 16 American wire gauge—0.0253, 0.0359, or 0.0508 in. diameter) mounted on insulators on the crossarms of poles (open-wire lines); of aerial cables, maintained under nitrogen gas pressure to check for leaks and warn of entry of moisture; and of underground cables buried directly in the ground (armored cable) or else run in ducts.

Lead, hardened by alloying with small amounts of antimony (about 1 per cent) or tin, is usually used for the cable sheath to exclude moisture; more recently, polyethylene has been successfully used. In submarine cables for crossing rivers and other bodies of water, treated paper, rub-

ber, or gutta-percha is used for insulation; and a continuous spiral of high-permeability metal (permalloy) is used over each pair of wires in the cable as inductive loading, if the cable is very long.

**Telephone Repeaters.** Telephone repeaters are amplifiers inserted along a telephone line at suitable intervals (from 50 mi., for open-wire lines, down to 8 mi., or so, for cables) to compensate for the attenuation of the signal in the section of the line preceding the repeater. Since an amplifier transmits in one direction only, separate channels are required, unless a balancing network is employed.

**Coaxial Lines.** To minimize interference pickup, a coaxial cable can be employed instead of a two-wire line, balanced-to-ground. A coaxial cable has an outer tubular conductor concentrically surrounding an inner conductor and separated from it by insulating ceramic or polyethylene disks. Dry nitrogen gas is usually pumped into it to exclude moisture and to prevent corrosion. The losses decrease as the size of the cable is increased. The standard size is ⅜ in. for the inner diameter of the outer conductor. Owing to skin effects, the currents are more and more confined to the inside of the outer conductor and the outside of the inner conductor, as the frequency is increased. This condition makes the cable particularly well shielded at the higher frequencies where inductive and capacitive pickup is normally greater, and, hence, results in a more favorable signal-to-noise ratio. The coaxial cable can be operated over wide frequency bands, and, therefore, is particularly suited to carrier telephony and television.

## RADIOTELEPHONY

**System of Transmission.** Various frequencies and methods of modulation are employed in radiotelephony, depending upon the distance of transmission, the importance of the link, and the privacy required. Low (long-wave) frequencies —40 to 100 kilocycles (kc.)—were used originally, but are now merely for standby purposes. Higher (short-wave) frequencies—5 to 30 megacycles (mc.)—are used because they are freer from atmospherics and can traverse long distances by one or more reflections from the ionosphere, or Heaviside layer; however, they can be disrupted by magnetic storms. Different frequencies are required for day and night operation, and as many as five frequencies are required for transatlantic transmission. Short-distance point-to-point transmission uses the 100- to 5,000-kc. and 30- to 3,000-mc. bands, or even higher.

At the lower frequencies, amplitude modulation, either double sideband and carrier, or single sideband with carrier suppressed and supplied locally at the receiver, is employed. In the ultrahigh bands, from 100 mc. up, phase or frequency modulation is often used, as well as pulse-time modulation.

To ensure privacy, as in transatlantic transmissions, the speech is scrambled by inverting and/or transposing bands in the audio spectrum before modulating the carrier, and the code is changed periodically.

**Installation.** The installation of the receiver and transmitter depends upon the type of service desired.

*Long-Distance Systems.* Owing to the high transmitted power, the receiving and transmitting antennas are generally separated by an appreciable distance, and, if directional, have their nulls in line, in order to prevent the transmitter from paralyzing the receiver. Usually, different frequencies are employed for the two directions of transmission; further refinements are to shut off the transmitter carrier by voice-operated relays when the receiver is operating, and vice versa. Short-wave reception generally involves the use of rhombic antennas, which are directional and broad-band in operation.

*Ship-to-Shore Systems.* Here, the frequencies range from 2 to 30 mc. and 152 to 162 mc. The coastal calling frequencies lie in the 2- to 3-mc. band, and a ship may carry two to three crystals in order to change frequency rapidly to communicate with the desired shore station. For long-distance communications involving ships on the high seas and land lines, frequencies in the 4- to 21-mc. range are used. The 152- to 162-mc. bands are employed for private communication systems by important marine commercial companies. Even though space may be at a premium, the receiver should be located in the quietest part of the ship. This injunction should be observed particularly for the receiving antenna, which should also be as far as possible from the transmitting antenna. Shore stations are moderately directional, and the receiving antenna is located in as quiet a region as possible. The antenna sites should be as close to the water as possible in order to avoid the large attenuation of any intervening land.

*Railway Systems.* Radiotelephone systems are employed by railroads to enable the caboose and locomotive of long (80-car) freight trains to communicate with each other and with stations along the right of way. The set in the locomotive operates from a 32-volt turbogenerator; that in the caboose, from a gasoline-driven generator. The ultrahigh frequencies employed, 159.51 to 161.85 mc., permit small antennas, mounted on top of the locomotive or caboose, and afford ample clearance for bridges. The transmitter power is about 10 watts, and frequency modulation is employed (±15 kc. swing). Although static is at a minimum at these frequencies, flutter effects and noise have indicated the advisability of installing additional booster stations along the right of way. The boosters are usually fed from the main stations by carrier frequency (189 kc.) along the wayside wire circuits. Reliable communication over distances of 13 mi., or more, is possible.

*Vehicular System.* Radiotelephone communication with automobiles was introduced at the close of World War II. Each car has a small receiver and transmitter, usually located in the trunk compartment, with a push-button control on the handset to connect either unit to the common antenna mounted on the roof. Receivers are located along the highway to pick up the car signal, whereas one or a few powerful transmitters radiate power to the vehicles. A selective ringing system enables any one vehicle to be called. The mobile service bands are 25 to 50 mc., 150 to 160 mc., and 450 to 460 mc.

A. Pr.

**TELESCOPE.** *See* Astronomical Instruments; Optical Instruments (*Visual Instruments*); Observatories.

**TELESCOPIUM** [təlĕsko′piəm], the Telescope, a modern southern constellation, centered approximately at right ascension, 19 hr. 20 min.; declination, — 51°. It is not wholly visible above 33° N. lat. It includes a region quite barren of conspicuous stars as it contains none brighter than the fourth magnitude.

J. H. P.

**TELETYPE SYSTEMS.** *See* Telegraphy.

**TELEUT.** *See* Asiatic Tribes (*Turkic*).

**TELEVISION,** the transmission and reception of visual images in motion by electrical means. Actually, it consists of converting the lights and shadows of a scene into corresponding electric signals which may be broadcast, or trans-

mitted over radio relay and coaxial cable circuits. At the receiver these signals are reconverted into a visible image which recreates the original scene.

**History.** The concept of television was first advanced in 1877 by a Frenchman, Senlecq. He proposed that an image might be transmitted electrically by focusing it on a mosaic made up of a number of selenium cells, each connected to an individual electrical circuit capable of actuating a shutter, the shutters being arranged in a mosaic similar to that of the cells. In 1884, the German Nipkow proposed a simpler system in which a single electrical circuit might be used. In the Nipkow system, the image was to be scanned, that is, analyzed point by point by viewing it through holes on the periphery of a rotating disk. Each hole would trace across the image a line adjacent to that traced by the preceding hole. A selenium cell or other photosensitive device would register the amount of light passing through the holes from instant to instant, thus creating a varying current which, after passage through the circuit, would actuate a lamp illuminating a flat surface. If this surface were viewed through the holes of a second similar disk, rotated synchronously with the first, the image would be recreated. Nipkow's scheme is the basis of modern television systems.

The principle of the electronic scanner was first enunciated in 1907, when Rosing in Russia and Campbell-Swinton in England independently proposed a method of storing an image electrically on a plate, in a manner similar to the storage of the latent image on a photographic plate. The latent electrical image was to be scanned electrically by a beam of electrons which passed over the plate in a series of parallel lines and created a changing current proportional to the changes in light and shade along each line. This proposal was reduced to practice by V. K. Zworykin in 1925, when he applied for the patent on the iconoscope, the basic element of the electronic television camera. The other essential element of the electronic system, the cathode-ray tube on which the picture is reproduced at the receiver, was first constructd by Braun in the early 1900's.

The first demonstrations of television transmission over wire lines were conducted in 1925 by John Logie Baird in England and Charles F. Jenkins in the United States, both using the Nipkow-disk system. In 1927, the Bell Telephone Laboratories transmitted images by this method over telephone wires between Washington and New York. In 1933, the Radio Corporation of America demonstrated an electronic system, using the iconoscope and cathode-ray tube, between New York and Philadelphia, using radio waves with a relay at Arney's Mount, New Jersey. In 1936, public television service, using a similar electronic system, was inaugurated in London. In the same year, RCA began a large-scale field test of this system in New York City. Public television service was begun in 1939 but was interrupted in 1940 by the Federal Communications Commission to permit a review of the standards of transmission. After this review was completed in 1941, full commercialization of the electronic system was permitted by the FCC in July of that year. Broadcasts continued during World War II at a reduced scale and were resumed at an accelerated pace in 1946. Large-scale production of receivers for the public began in 1947, when twelve stations were furnishing regular service to the public in nine cities. By November 1952, more than 100 additional stations had taken the air, and were connected in a coast-to-coast network serving 20,000,000 receivers.

**Systems of Television—Requirements.** The television image is re-created by a moving spot of light, which traces a number of parallel horizontal lines across the viewing

NATIONAL BROADCASTING COMPANY

*Televising a meeting of the United Nations at their headquarters in New York City*

screen. As the spot moves along each line, its brightness is changed, under the control of the signal broadcast by the transmitter, so that it re-creates the lights and shadows along each line. When the picture area has been covered by a series of such lines, the light spot returns to the starting point and traces out another picture, differing slightly from the preceding one. This succession of pictures, like the successive frames of a motion picture, recreates the image in motion. According to the United States standards, 30 complete pictures are traced out each second, and the total number of scanning lines from the beginning of one picture to the beginning of the next is 525. (In Great Britain, 25 pictures, each containing 405 lines, are sent each second.) Of the 525 lines, approximately 35 lines are blanked out while the spot travels from the bottom of one picture to the top of the next, leaving about 490 active lines for recreating the picture. Each of these active lines is capable of being shaded with some 450 dots (picture elements) of light and shade. Consequently each picture may contain as many as $490 \times 450$, or 220,500, picture elements. On a similar basis of computation, the number of picture elements which may be accommodated in the image projected from a single frame of 16-mm. motion picture film is about 250,000. Thus the 525-line television system and the 16-mm. home movie have comparable ability to reproduce the details of a picture.

Since the television picture, containing as many as 220,500 picture elements, is sent in 1/30 sec., it follows that picture information must be sent from transmitter to receiver at an enormously rapid rate, as high as seven or eight million picture elements per second. To accomplish this rapid transmission, a correspondingly broad space in the ether spectrum is required, roughly equal to that demanded by 600 standard sound broadcasting stations. Since such space cannot be found in the broadcast or short-wave regions of the spectrum, which are already thoroughly occupied by existing radio services, television frequency assignments are confined to the very-high frequencies (vhf), channels 2-13, operating on 54 to 216 megacycles, and ultra-high frequencies (uhf), channels 14-83, operating on 470 to 890 megacycles. For connecting television stations in intercity networks, specially designed coaxial cables or radio-relay facilities must be used.

The very short radio waves used by television stations are not propagated around the curvature of the earth, as are those used for standard and short-wave broadcasting. Consequently, the range over which television transmissions may be received is limited substantially to the horizon as viewed

from the transmitting aerial. Reliable coverage over a maximum radius of 50 to 75 mi. is possible, provided the transmitting aerial is elevated from 250 to 1,000 ft. above the surrounding terrain.

**Broadcasting Programs.** The modern television camera (iconoscope and image orthicon, described under Television Cameras, below), has all the capabilities of the motion-picture camera. The image orthicon is, in fact, more sensitive to light than the fastest photographic film, when exposed for the 1/30-sec. interval allowed for each picture. This camera can televise a recognizable picture in the light of a single candle held 6 ft. from the subject. The producer of television programs is thus freed from limitation as to subject matter, so far as illumination is concerned. The principal limitation is, rather, the available detail of the recreated picture. In common with motion pictures, the television system gives the best effect when the subject is viewed in a close-up. Telephoto lenses are often used in sporting events to bring the center of action close to the viewer.

*TYPICAL TELEVISION STUDIO SCENE*

NATIONAL BROADCASTING COMPANY

**Television Cameras.** The television camera employs the photoelectric effect to translate the optical image into an electrical signal. The image is focused by a lens onto a photosensitive surface, enclosed within an evacuated glass tube (camera tube). When light strikes such a surface, electrons (minute negatively charged particles) are freed from the plate in numbers proportional to the intensity of the illumination.

*Iconoscope.* The first widely used television camera was the iconoscope. The photoelectric surface in this device is a flat plate of mica, covered on one side with a mosaic of several million separate minute droplets of cesiated silver. The image is focused optically on this plate, called the "mosaic plate," and electrons are liberated from each droplet in proportion to the value of light or shade falling on each. Each droplet is insulated electrically, by the mica, from its neighbors. Hence as the negative electrons are liberated, the mosaic of droplets is left with a distribution of positive charge which corresponds, point by point, with the distribution of light and shade in the image. As the illumination continues for the 1/30-sec. exposure of each picture, the charge is stored; that is, full use is made of the available light.

To dissect the image, a beam of electrons is directed at the mosaic plate from a side arm in the tube. This beam is caused to trace, over the mosaic, a series of parallel horizontal lines, scanning the image along each line from left to right and line by line from top to bottom. As the electron beam encounters the charged droplets along each line, it restores the charge of each droplet to equilibrium. These successive restorations of electric charge are reflected, electrically, to an external circuit connected to the rear side of the mica mosaic plate. Hence, as the electron beam moves over the charge image, an electrical signal is generated, the strength of which is proportional at any instant to the charge on the droplet being passed over by the beam at that instant. In this manner, the television signal is caused to vary in conformity with the successive values of light and shade along each line in the image. This signal, at the receiver, controls the brightness of a spot of light which is moving in synchronism with the beam in the camera, and the image is thus re-created.

*Image Orthicon.* The image orthicon camera operates on a similar principle, with refinements which increase its optical efficiency by about ten times over the conventional iconoscope. The image orthicon offers still greater sensitivity by employing what is known as electron multiplication. In this device, the electrons from the charge image are caused to strike upon several specially prepared surfaces, being reflected from one to the next. At each surface, the impact of one electron is sufficient to cause the release of approximately four "secondary" electrons, with a corresponding increase in current at each impact. By cascading several impacts, the current may be built up to a value several thousand times its original value, with proportional increase in the sensitivity of the camera. The image orthicon is currently the most widely used camera tube.

**Television Antennas.** The transmitting and receiving antennas used in television must meet rather exacting specifications compared with those used in sound broadcasting.

*Transmitting.* The transmitting antenna must be erected on as high an eminence as possible, such as a hill, tower, or skyscraper, to push back the horizon as far as possible. An antenna located well above surrounding buildings and terrain is also advantageous in minimizing the effect of signal reflections which cause ghost images, described in the next paragraph. The transmitting antenna should radiate the major portion of its signal in the direction of populated areas. If, as is usual, these areas surround the station, the antenna must not be directional in the horizontal plane. Directivity in a vertical direction is desirable, since such directivity confines the major portion of the radiated signal to angles below the horizon, where it can be utilized, and minimizes radiation above the horizon, where it would be lost to outer space.

*Receiving.* The receiving antenna, in contrast to the transmitting aerial, should have directional pickup in the horizontal plane. This directivity permits the antenna to discriminate between several signals arriving from the transmitter via different paths. One such signal, called the direct wave, travels directly from the transmitter to the receiver in a straight line. It arrives at the receiver first and is ordinarily the strongest component received. Other signals, called reflected waves, are reflected from buildings, bridges, water towers, cliffs, and other obstructions lying between transmitter and receiver. These reflected waves travel longer distances than the direct wave in arriving at the receiver and, hence, arrive later. Although they are usually weaker than the direct wave, the reflected waves are capable of producing ghost images, that is, faint replicas of the primary image, displaced to the right on the receiving screen. A directive receiving aerial, aimed in the direction of the direct wave, is of assistance in minimizing these ghost images and also in discriminating against interference from other stations.

The simplest receiving aerial is the so-called half-wave dipole, a horizontal rod with an insulating segment at its center, mounted on a vertical support. The length of the rod should be approximately one-half of the wave length employed by the transmitting station, for example, 2 meters for a station operating at 4 meters wave length. Such an antenna has maximum sensitivity along a line at right angles to its length. Higher degrees of directivity and proportional increases in sensitivity can be achieved by assembling an array of several half-wave dipoles parallel to one another.

When it is desired to receive all of the channels assigned to television stations, a single receiving aerial is at a disadvantage, since its length is best suited for one wave length. The antenna can be made to cover several station frequencies if the rod is of large diameter, or if each half consists of several fanned-out rods. Usually, however, at least two antennas are required to cover all the station frequencies. The receiving aerial should be located as high, and as clear of obstructions, as possible.

The lead-in wire is composed of two conductors, one connected to each of the dipole segments. The lead-in should be constructed of high-quality materials to avoid loss of the signal during its conduction from the antenna proper to the receiver. Signal reflections along the lead-in must also be eliminated, since the slightly displaced images thereby introduced may impair the fine detail of the image.

**Television Receivers.** A television receiver consists of two essential units, the picture receiver and the sound receiver. The transmitter radiates two corresponding signals, one carrying picture and synchronizing information, the other the accompanying sound. Both signals are picked up together by the receiving aerial and are tuned in by the same receiving circuits.

The sound circuits are of the frequency-modulated type. The picture circuits include the picture-signal amplifier and detector, the picture tube, and the synchronizing and scanning circuits which form the scanning pattern on the picture-tube screen. The picture amplifier and detector accept the picture signal as it arrives from the transmitter and amplify it to sufficient strength to control the brightness of the scanning spot as it moves over the picture-tube screen.

*Picture Tube.* The picture tube (cathode-ray tube, kinescope) is a funnel-shaped glass structure, closed at the wide end, and highly evacuated. Inside the glass at the wide end is a coating (a mixture of fluorescent powders) which glows when electrons impinge on it. This coating is the picture screen. The opposite (narrow) end of the tube contains an electron gun, a structure which forms a beam of electrons and directs it at the screen, where it creates a spot of light. The brightness of this spot is controlled by applying the picture signal to an electrode in the electron gun.

*Deflecting System.* At the mouth of the electron gun, where the electron beam first emerges, is the deflecting system, which causes the electron beam to change its direction. The spot formed by the beam is thus caused to traverse the screen in the parallel lines of the scanning pattern. It is necessary that these lines be formed in exact synchronism with the corresponding scanning motions in the camera at the transmitter. Synchronism is achieved by so-called synchronizing signals, which are generated at the transmitter and transmitted as a part of the picture signal. The synchronizing signals are separated in the receiver from the amplified picture signal and are applied to the deflecting system. In this manner, the spot of light is constrained to move over the screen in step with the corresponding scanning motion at the transmitter, changing in brightness as it moves and recreating the image point by point. Although only one spot is illuminated at any one time, the eye retains the impression for the full duration of each picture, or $\frac{1}{30}$-sec., so that the picture area appears as though it were continuously illuminated at all points.

*Magnifying System.* The picture screen may be viewed directly, or the image may be magnified and projected through a mirror and lens system to a larger viewing screen. In the latter case, the image formed on the cathode-ray screen must be very bright, since the magnification reduces the brightness in proportion to the increase in picture area.

*Contrast and Brightness.* The contrast control affects the amplification of the picture signal. Advancing this control causes the dark areas of the picture to become darker and the light areas lighter. The brightness control adjusts the over-all brightness of the picture, increasing or decreasing the light in all parts of the picture. In general, it is necessary to adjust both contrast and brightness controls until the picture is bright enough to be viewed comfortably in the surrounding illumination, while at the same time preserving an even gradation of light from white to black. Modern picture tubes can display a contrast ratio, between maximum white and black, of 60 to 1, which compares favorably with the contrast of motion-picture images. The maximum brightness currently available is about 75 foot-lamberts, which compares with less than 5 foot-lamberts on the average motion-picture theater screen.

*Focus and Synchronization.* The focus control affects the size of the scanning spot; it is adjusted to the position giving

the best rendition of fine detail. The synchronizing controls are adjusted if the image should fall out of synchronism with the transmitter, as evidenced by a torn appearance of the image or by the fact that the image as a whole moves vertically up or down on the screen. In many receivers, the synchronizing and focus controls are automatic in operation and are accessible only from the rear of the cabinet for adjustment during installation or for servicing.

*Size of Image.* As the development of television receivers has proceeded, the size of picture tube screens used in commercial receivers has increased from 10 to 30 in. The most popular sizes in 1952 were the 17-in. and 21-in. rectangular screens; the 27-in tube was expected to be popular in 1953.

Projected images up to 3 by 4 ft. in size have been offered in home receiving equipment, but are little used because they are so dim as to require complete darkening of the room. Projection television systems for theater use were installed in more than 100 theaters by 1952; in one drive-in theater, an image measuring 18 by 24 ft. was projected during the 1952 Walcott-Charles heavyweight prize fight.

*Test Patterns.* Most television stations broadcast a test pattern prior to each broadcast to aid the viewer in adjusting his receiver. This pattern contains areas of several shades of gray as well as white and black, one or more circular figures, two or more groups (wedges) of converging lines, as well as the station call letters.

**Color Television.** Late in 1950, the Federal Communications Commission (FCC) authorized the transmission of color television images by the "field-sequential" method, according to standards advocated by the Columbia Broadcasting System (CBS). In this system, the television camera is fitted with a rotating disk containing segments of transparent colored filters in the three primary colors, red, green, and blue. The rotation of the filter disk is synchronized with the scanning of the image, so that successive images are perceived in successively different colors. Thus, the scene is scanned first in red light, then in green, next in blue, and then again in red, and so on. At the receiver, a similar rotating disk, large enough to cover the screen of the picture tube, is rotated synchronously with that at the transmitter. Thus, when the camera is viewing the scene through a red filter, the viewer perceives the screen through a corresponding red filter; the filters correspond similarly during the images scanned in green and blue light. Since the images follow one another in rapid sequence, the primary-color images fuse in the mind of the viewer and a full-color reproduction results.

To avoid flicker in this system, the images must be scanned at a much faster rate than is required in the black-and-white system (actually, more than twice as many pictures must be sent each second in the field-sequential color system as in the black-and-white system). Consequently, the color image cannot be received on existing monochrome receivers unless the receiver is extensively modified. This incompatibility of the CBS color system with existing television receivers placed the system under a heavy economic handicap. Moreover, the filter disk at the receiver cannot safely be rotated at the high speed required if its diameter exceeds about 24 in., which limits the picture size to about 12 in. For these reasons, when color broadcasts were instituted in 1951 by CBS in New York, other broadcasters did not follow suit and the public showed little interest. Production of color receivers was halted later that year by the National Production Authority to conserve critical materials. These curbs were lifted in June 1953, but color television was not resumed pending further developments.

To avoid the limitations of the CBS system, the television industry in 1950 requested the National Television System Committee (NTSC) to study the possibilities of compatible color systems (that is, those which would permit existing black-and-white receivers to reproduce the new color transmissions in monochrome without any modification of the receivers). In late 1953 a new compatible color system, developed by the industry through NTSC, was adopted by the FCC, and regular color broadcasts on a limited scale began shortly thereafter. Known as the "simultaneous system," it transmits the three primary colors at the same time. The basic signal is identical with that used in black-and-white transmissions; and the simultaneous color signals are transmitted over the same channel in such a way that they do not affect reception existing on monochrome receivers,

COURTESY OF RADIO CORPORATION OF AMERICA

OPTICAL DEMONSTRATION OF RCA TRICOLOR TELEVISION TUBE

*In the actual RCA tricolor tube, shown to the left in sectioned form, the electron beams for each of three primary colors—red, green, blue—pass through a masking screen containing 200,000 tiny holes to activate phosphor dots on the glass viewing plate. There are 600,000 dots on the glass plate arranged in groups of three—one dot in each group for each of the three primary colors. By means of the masking screen, each color is reproduced on the glass plate in succession; the interval between colors is so short, the illusion is given of a continuous full-color picture. (1) Arrangement of blue phosphor dots on viewing plate; (2) Green dots; (3) Red dots.*

but may be utilized in color receivers to produce full-color images. Concurrently, tricolor picture tubes have been developed which employ viewing screens made of some 600,000 dots of fluorescent material, 200,000 for each of the three primary colors. These tubes, used in a compatible system, can provide a color image with all the quality of the black-and-white images in respect to detail, freedom from flicker, and suitable picture size. Commercial production of picture tubes up to 21 in. in diameter was well under way during 1954. *See also* ELECTRON TUBES (*Cathode-Ray Tubes*); FACSIMILE.

D. G. F.

**TELFORD, THOMAS** (1757-1834), Scottish engineer, was born on Aug. 9, 1757, in Elkdale, Dumfriesshire. He became a stone mason in Edinburgh in 1780 and a hewer in London two years later. He was commissioned to direct the erection of several buildings in 1784, and in 1787 he was appointed surveyor of public works for Shropshire. In 1793, Telford was designated sole agent, engineer, and architect of the Ellesmere Canal to connect the rivers Mersey, Severn, and Dee. Among the spectacular engineering feats he accomplished in carrying out this project was the building of huge aqueducts to carry the canal across valleys. Telford also engineered the Caledonian Canal, permitting navigation through Scotland from the North Sea to the Atlantic Ocean. This canal, 60 mi. long and having twenty-eight locks, was under construction from 1804 to 1822 but was not a financial success. During this period, Telford also was active in building canals in England as well as on the Continent, including the Gotha Canal (1808-1810) from the Baltic to the North seas.

Telford also built roads and bridges, including 900 mi. of roads and 120 bridges in northern Scotland. His remuneration was frequently meager, but he took great pride in these improvements for his native country. The King of Sweden conferred upon him the order of knighthood. Telford was a founder of the society which became the Institute of Civil Engineers. He died in Westminster, England, on Sept. 2, 1834, and is buried in Westminster Abbey. I. B.

**TELL, WILLIAM,** legendary Swiss patriot, is popularly believed to have been born in the canton of Uri in the latter part of the thirteenth century. The central incidents of the Tell story are supposed to have occurred in 1307, when one Gessler is said to have been tyrannically abusing his office as Austrian governor of Uri. According to the accounts, William Tell, a native of the district, refused to make obeisance to Gessler's hat which had been displayed publicly as the symbol of Austrian authority. In punishment, Tell was reputedly forced to shoot an arrow through an apple resting on the head of his son. Tell is said to have performed the feat but to have been thrown into chains upon his confession that, had he harmed his son, he would have sped a second arrow through the governor's heart. The story continues to relate that while Tell was being taken across Lake Luzern as a prisoner, a violent storm gave him an opportunity to escape. The story ends with a final meeting between the Swiss hero and the governor in which Gessler was killed by Tell's arrow.

This story, which furnished the theme of Schiller's famous poetic drama *Wilhelm Tell* (1804) and of Rossini's opera *Guillaume Tell* (1829), is interwoven with the legendary history of the origin of the Swiss Confederation and the medieval Austro-Swiss struggles. It was first found in a ballad written before the sixteenth century. Early historians of the Swiss Confederation accepted the historical existence of Tell. Efforts were made by Aegidius (or Gilg) Tschudi and others to eliminate the inconsistencies and complete the story. According to Tschudi's *Schweizer Chronik* (1734-1736), Albert of Austria sent bailiffs to Uri and Schwyz to deprive them of their freedom; this produced an uprising on Nov. 8, 1307, and among the instigators was William Tell. The events of the Tell story took place on Nov. 18, 1307, and were followed by a general rising on Jan. 1, 1308. Since Joseph Kopp wrote a historical critique in 1835, historians have largely rejected the legends because of certain contradictions to known historical facts and because of the lack of agreement among the chroniclers themselves. Attempts were made as late as the 1930's, however, to use documentary sources to substantiate the existence of William Tell.

W. S. V.

**TELL** [tɛ′l], an Arab name for an artificial mound marking the site of an ancient city. In the ancient East it was usual to continue rebuilding on the same site. As the centuries passed and successive buildings were reared on the foundations and rubble of earlier ones, the levels of floors and streets gradually rose. In addition to collapsed walls of mud or sun-dried brick, rubbish and sand blown in from the desert helped to make the mound grow. Many of these ancient cities are abandoned, but some, like Erbil, the ancient Arbela, still crown their tells. By excavating tells layer by layer archaeologists are able to trace the development of architecture and of the arts and crafts of successive generations of city dwellers. In the Old World the most famous tells are found in western Asia, but analogous mounds are known from Greece and from parts of the Balkans. J. G. D. C.

**TELL CITY,** a city in Perry Co., in southern Indiana, situated on the Ohio River, 45 mi. east of Evansville. Coal mines and hardwood timber are in the vicinity. It is a retail trading center for the surrounding rural area of dairy, poultry, and stock farms. Tell City was settled by a colony of Swiss in 1857 and was laid out with a main street 80 ft. wide. It was named for the legendary hero, William Tell, and some of the manufacturers and merchants use as a trade-mark an apple pierced with an arrow. Tell City is governed by a mayor and council. The Southern Railway and river steamboats provide transportation. The chief local industry is woodworking. Pop. 1950, 5,735.

**TELL EL-AMARNA** or **AMARNA** [tɛ′l ɛl əmɑ′rnə], the capital of Egypt under Ikhnaton (Amenhotep IV: 1375-1358 B.C.), lies approximately halfway between Memphis and Thebes, occupying both sides of the Nile. It was founded to honor Aton, the sun-disk, whose worship Ikhnaton introduced to unify, if not replace, the old animal-headed Egyptian pantheon; this was the only attempt at monotheism Egypt ever made. The ancient name of the city was Akhetaton ("Horizon of Aton"), and all its contents were designed to please the god. Because of the historical certainty of the dates of its founding and abandonment, it is one of the most valuable archaeological sites in the world. The spacious city-plan is well preserved (excavations have been carried out by both German and British expeditions); it occupied an area about half a mile wide and two miles long, delimited by inscribed boundary-stones which are still to be seen, and contained royal palaces, fine villas, the great open temple of Aton, workers' quarters, and, beyond, the graves of its inhabitants. The city had wide tree-lined streets, many groves and gardens, and boating ponds.

Ikhnaton particularly emphasized "truth" in his new worship, as is evidenced in the well-known Hymn to the Sun. At the same time, a greater realism in art was encouraged, although how far this was also the result of foreign influences it is impossible to say. The clay tablets containing royal diplomatic correspondence found at Amarna show Egypt's many foreign connections, and the fact that this correspondence was carried out on both sides in Babylonian cuneiform further demonstrates the internationalism of the period. The gaily painted pavements of the King's palace, with their lively animals, fish, and plants, often seem Minoan in spirit, and the "flying gallop," a peculiarly Mycenaean convention, appears to confirm the source of this influence. Nofretete, Ikhnaton's queen, is generally supposed to have been a for-

eign princess, and one would like to think that she came from some part of the old Minoan realm. One of the most beautiful portrait sculptures of any country or of any age is the painted limestone bust of the queen in the Berlin Museum. Other fine sculptures, some strikingly realistic, were found at Amarna in the workshop of the sculptor Thùtmose.

We have many statues of Ikhnaton himself, in which the new naturalism sometimes seems extreme. The King appears to have been naturally ill-formed, with a paunch contrasting with his thin extremities, and a high, dome-shaped head; these peculiarities are not only faithfully rendered but often grossly exaggerated, and his courtiers and friends, perhaps from flattery but certainly not from realism, are depicted with the same physical defects. These appear in many tomb-reliefs from Amarna, where the King and Queen stand on the palace balcony, dispensing gifts to their subjects and worshipping Aton, a large sun-disk with rays, terminating in outstretched hands, streaming down upon his worshippers. The fresco in the Ashmolean Museum showing two of Ikhnaton's young daughters is charming in conception and composition, but the little girls are again pictured with their father's narrow shoulders, flabby paunch, and deformed head.

The influence of the Amarna School is still strongly apparent in the magnificent objects from the tomb of Tutankhamon, Ikhnaton's son-in-law, after whose reign Egyptian artists returned to their age-old conventions with scarcely a remembrance of the new approaches tried at Amarna.

Toward the end of Ikhnaton's reign, Egypt was in a weak position abroad, partly from Ikhnaton's neglect of foreign affairs in favor of his religious reform, and in internal disorder, partly as a result of the opposition of the priests of Amon (and perhaps of the populace as well) to the new religion. At the King's death, the new worship was rapidly abandoned, its works of art were obliterated wherever they could be found, the capital was returned to Thebes, and Amarna was left deserted. J. H. Y.

**TÉLLEZ, FRAY GABRIEL.** *See* TIRSO DE MOLINA.

**TELL HALAF** [tɛ'l hælɑ'f], an ancient settlement mound near Nusaybin on the Turkish side of the Turko-Syrian frontier, excavated by a German expedition in 1911 to 1913 and in 1929. Underneath a series of Hittite palaces with rich sculptures were found prehistoric levels. These yielded quantities of well-fired, hand-made pottery, comprising mainly bowls and flasks of a wide range of forms, decorated with polychrome painting. The paint, which is often shiny and includes black, red, orange, yellow, and white, was applied to a smooth cream or buff slip. Among the many distinctive designs were a number based on the heads of bulls and double axes. The pottery, which appears to have been manufactured in bulk in large domed kilns (examples were found at Arpachiya and Carchemish), was made in many regions of the Mediterranean, as at Mersin and Ras Shamra, and the Tigris, as at Tell Hassuna. It circulated among communities of a chalcolithic stage of culture, among whom stoneworking reached a high pitch of excellence but who were familiar with the casting in open molds of simple copper forms like flat axes and daggers. Other evidence of cultural advance is given by flasks and bowls of limestone and obsidian and by the wide-flung trade in pottery as well as precious substances. The appearance of stamp seals, engraved with distinctive patterns and looped for suspension on a cord, reflects the growth of personal wealth and commerce. J. G. D. C.

**TELL HASSUNA** [tɛ'l hæsu'nə], an ancient settlement mound twenty-two miles south of Mosul, Iraq. Excavation has revealed stages in the prehistoric settlement of Assyria from the Stone Age up till the period of metallurgy. The bottom yard of deposit showed three distinct levels of occupation, but no traces of solid buildings. No doubt the earliest settlers lived in tents or flimsy huts. Their culture was Neolithic. They fabricated polished stone axes, finely flaked tanged arrowheads, and hand-made pottery; they hunted wild animals, but their economy was mainly based on herding. Above this level, which represents the earliest settled culture in Assyria, there was a clear break, followed by seven yards of continuous occupation by agriculturalists, who, although using kohl and malachite as cosmetics, continued to depend on flint, stone, and obsidian for tool making. This thick accumulation can be divided into two parts: in the lower levels we find traces of the first mud huts together with incised pottery, like that already known from early deposits at Nineveh, and pottery painted with multilinear chevrons, like that from sites in northern Syria and southern Turkey, as at Mersin; in the later levels appear more elaborate houses, built round a courtyard and provided with elaborate baking ovens, in which the pottery is decorated with patterns in black paint on a pale ground like that from Samarra, farther down the Tigris. Above this, there occurred a second break in the occupation of the mound, followed by a phase in which polychrome pottery of Tell Halaf type appeared, together with seals, chariots, and copper axes and daggers. J. G. D. C.

**TELLURIDES** [tɛ'lyuraidz], a group of mineral compounds of gold and silver with tellurium. Most common tellurides are calaverite, $AuTe_2$, and sylvanite (Au,Ag) $Te_4$. These minerals range in color from silver white to steel gray. The simplest test for tellurium is to heat the mineral on charcoal in a reducing flame; tellurium colors the flame a distinctive bluish green. The tellurides are easily fused and roasted to obtain a gold button. Tellurium minerals are found in low-temperature hydrothermal veins. At Cripple Creek, Colorado, tellurides are the sole ore of gold. They occur in veins which ramify through the neck and flanks of a Tertiary volcano. Tellurides are occasional ores in other localities, including Ontario and western Australia. K. K. L.

**TELLURIUM** [tɛlʊ'riəm], symbol Te, atomic number 52, at. wt. 127.61, density 6.24, m.p. 452° C., b.p. 1,390° C. Tellurium (Latin *tellus,* earth) is the fourth member of Group VI-B of the periodic table, where it is preceded by oxygen, sulphur, and selenium and followed by polonium. Tellurium closely resembles sulphur and selenium, and it is widely distributed in nature, usually in small proportions. It is commonly associated with sulphur and selenium in the uncombined state; tellurides of gold, silver, lead, mercury, bismuth, nickel, and copper are found.

Tellurium forms grayish, lustrous, brittle crystals which are insoluble in water and carbon disulphide and conduct heat and electricity poorly. Tellurium burns in air, forming $TeO_2$, which is white and odorless and almost insoluble in water. Both tellurous acid, $H_2TeO_3$, and telluric acid, $H_2TeO_4$, are extremely weak. Tellurium and its compounds have few commercial uses. It is added to lead to increase its hardness, toughness, and resistance to corrosion; it also increases the life of rubber tires and imparts color to glass. B. S. H.

**TELLUS** [tɛ'ləs], an ancient Italian deity of earth, a goddess of marriage and fertility later identified by the Romans with the Greek Gaea. *See also* GAEA. G. E. D.

**TEMESVÁR.** *See* Timişoara.

**TEMNE.** *See* African Peoples.

**TEMPE** [tɛ′mpi], a city in Maricopa Co., in south central Arizona, situated on the Salt River, 10 mi. southeast of Phoenix. The city, originally called Hayden's Ferry, was founded by Charles Hayden and was incorporated in 1894. A health center and college community, it is the seat of Arizona State College and a state welfare sanitarium. The Gila River Indian Reservation is 10 mi. southwest of the city, which has transportation furnished by the Southern Pacific Railroad. Pop. 1950, 7,684.

**TEMPERA** [tɛ′mpərə], a method of painting in which solid pigments are mixed with water, and some kind of gum or gelatinous substance, usually the white of an egg, is then added to act as a binder. Pure tempera is invariably opaque, and colors are lightened by the addition of white pigment. The chief advantage of this medium is the durability and lasting brilliancy of the colors; the disadvantages are the fast-drying properties of the paint and the difficulty of blending colors on the paint surface.

Tempera was used for murals in ancient Egypt, and by Greek painters in the fourth century B.C. After this date it was used continuously as the standard method of painting in Europe until the introduction of oil techniques in the early fifteenth century. Thereafter tempera was combined with oil in a technique known as underpainting, in which a monochrome painting in tempera is first completed, the surface is then varnished, and finally color is applied by means of transparent oil glazes. This technique was used for virtually all easel painting until the seventeenth century.

Currently tempera is used as a fine art medium, and as a separate technique in a wide variety of fields, notably architectural rendering and advertising layouts, where its adaptability to use by the airbrush makes it especially suitable.

H. L. C.

**TEMPERAMENT, MUSICAL,** an alteration in the pitch of notes in order to improve mistuned intervals. The most ancient tuning was described by the followers of Pythagoras in the sixth century B.C. In it the diatonic scale was tuned to pure octaves, which have a ratio of vibration frequencies of 2:1, and pure fifths, with a ratio of 3:2. This Pythagorean scale was advocated by Boethius in the sixth century of the Christian Era and was apparently the only tuning used in the Middle Ages. In this tuning the thirds (81:64) are very sharp. Such a note as G-sharp is higher than A-flat by the Pythagorean or diatonic comma, with a ratio of about 74:73. The Pythagorean tuning is excellent for melody but less satisfactory for harmony because of its sharp thirds. A violinist who tunes by pure fifths and who plays sharped notes higher than enharmonically equivalent flatted notes comes close to the Pythagorean ideal.

One of the tunings described by Claudius Ptolemy in the second century of the Christian Era had pure major thirds (5:4) as well as pure octaves and fifths. In it A-flat is higher than G-sharp, in contrast with the Pythagorean tuning, and the interval between the pure third and the Pythagorean third is the Ptolemaic or syntonic comma (81:80). Forgotten for centuries, this tuning was revived in the sixteenth century by Lodovico Fogliano (died c. 1539). It is generally called "just intonation." As applied to the complete chromatic octave, just intonation had two limitations. One was that notes could not be used in place of their enharmonic equivalents, so that if G-sharp was present, A-flat could not be, and modulation was limited to keys with two flats and three sharps. The second limitation was that certain triads within the above bounds, such as D-F-A, were unusable because of their dissonant intervals.

In order to equalize this second fault of just intonation, temperament was used. Pietro Aron (c. 1490-1545) recommended lowering each fifth by one-quarter comma, so that the major thirds (reached by four fifths, as C-G-D-A-E less two octaves) would be pure. This is called the meantone tuning or temperament, because in this system the interval C-D, for example, is precisely half the major third, C-E. As in just intonation, G-sharp is lower than A-flat in the meantone temperament. Although this temperament admirably solves one problem by substituting four small errors in the fifths for one large one in the third, it has the same limitations as just intonation with regard to modulation to the more remote keys. This tuning was intended primarily for keyboard instruments, such as the organ and the harpsichord.

Aristoxenus (fourth century B.C.) described somewhat vaguely a tuning in which the semitones are equal halves of tones, and he may thus be considered the forerunner of the sixteenth- and seventeenth-century writers who advocated equal temperament, in which the octave is divided into twelve equal semitones. The fifths of equal temperament are only slightly flat, but its thirds are quite sharp. G-sharp and A-flat in this system are, of course, the same note.

In the sixteenth century, equal temperament was used for fretted instruments, the lutes and viols of the time. During the seventeenth century it must have attained a certain vogue for keyboard instruments also, if its warm advocacy by Marin Mersenne (1588-1648) is taken into consideration. But not until after J. P. Rameau (1683-1764) had advanced the theory and J. S. Bach (1685-1750) had furthered its practice by writing *The Well-Tempered Clavier* did equal temperament gain general acceptance for keyboard instruments. Even so, organs retained their old, unsatisfactory tuning longer than did pianos.

Equal temperament is presumably the tuning that every one accepts today. Brass instruments still have tendencies toward just intonation, however, and strings toward the Pythagorean tuning; piano tuners, besides, are not infallible; and as long as these conditions persist, it is clear that equal temperament cannot strictly be said to be in universal use.

J. M. Ba.

**TEMPERANCE LEAGUE OF AMERICA.** *See* Anti-Saloon League of America.

**TEMPERATURE.** *See* Heat and Thermodynamics; Measurements, Standards and Units of; Meteorology (*Weather and Weather Observations*).

**TEMPERLEY, HAROLD WILLIAM VAZEILLE** [tɛ′mpərli] (1879-1939), English historian, was born in Cambridge on Apr. 20, 1879, and was educated at Sherborne School and at King's College and Peterhouse, Cambridge. He was a fellow of Peterhouse and tutor in history there from 1904 to 1938, when he was elected master of Peterhouse. He lectured at Cambridge first as reader in modern history and then, from 1937, as professor in the newly created chair in that subject. He also lectured at Harvard (1911-1912) and Stanford (1936), and was Ford Lecturer at Oxford (1937-1938). He was president of the International Historical Congress from 1933 to 1938. After serving during the first World War in the Dardanelles and at Salonika, Temperley became a member of the Allied mission to Montenegro and of the Albanian Frontiers Commission (1921). As the official English historian of the Peace Conference, he edited *A History of the Peace Conference of Paris* (6 vols., 1920-

1924). Among other important works are *Life of George Canning* (1905), *Frederick the Great and Kaiser Joseph* (1915), *History of Serbia* (1917), *The Foreign Policy of Canning* (1925), *British Documents on the Origins of the War* (ed. with G. P. Gooch, 11 vols., 1926-1938), *England and the Near East* (Vol. I, *The Crimea*) (1936), *Foundations of British Foreign Policy, 1792-1902* (1938), and *A Century of Diplomatic Blue Books* (1939). A sound scholar, he was undoubtedly the leading English authority on modern diplomatic history. He died at Cambridge on July 11, 1939.

E. R. A.

**TEMPEST, THE** (1611), a tragicomedy by Shakespeare, probably the last play attributable to his sole authorship. The theme—a storm, a shipwreck, and the adventures of the shipwrecked party on an enchanted island—was suggested to Shakespeare by the reports received in London late in 1610 of the wreck of an English ship off the Bermudas and the unexpected survival of her crew after a winter's sojourn in those islands. It was a topic for a timely play, but it had little or nothing of a plot. Somewhere, however, in old stories and in Italian comedies Shakespeare picked up accounts of a banished prince who was also a wise magician. This sage had a fair daughter whom he contrived to marry to the son of a hostile king in order to end an old feud. This action and these characters, magician, daughter, prince, and king, Shakespeare set in an enchanted island after a shipwreck, and the result was *The Tempest.*

The plot of *The Tempest,* which alone among Shakespeare's plays observes the unity of time, is one of the author's slightest. In spite of its lack of exciting action, however, *The Tempest* contains something for all tastes: lovely songs; a stately masque, with music and dancing; spectacles that must have taxed the resources of the Blackfriars stage; the farcical comedy of Caliban, the drunken butler and the jester; the love story of Ferdinand and Miranda; and, controlling and directing all, the figure of the wise and benevolent magician Prospero. All this is for the theatre; for the thoughtful reader there is more: the ineffable beauty of the verse; the serene wisdom of the thought, with its insistence on repentance and reconciliation; and, above all, the haunting sense that this play may be the master's farewell to the art with which he had wrought such wonders. The famous lines given to Prospero, beginning with the words, "Our revels now are ended," seem to utter Shakespeare's final judgment on man's little life.

T. M. P.

**TEMPLARS, KNIGHTS.** *See* KNIGHTS TEMPLARS.

**TEMPLE, HENRY JOHN.** *See* PALMERSTON, 3RD VISCOUNT (HENRY JOHN TEMPLE).

**TEMPLE, SIR WILLIAM** (1628-1699), English diplomat and man of letters, was born in London in 1628 and was educated at the Bishop Stortford grammar school and at Emmanuel College, Cambridge. In 1655 he married Dorothy Osborne, who became a famous letter-writer. He embarked on his diplomatic career in 1665 under the patronage of Lord Arlington, who sent him as envoy to the Bishop of Münster. From Münster he was sent to Brussels, and it was during this mission that he negotiated in 1668 the famous Triple Alliance between England, Sweden, and the Netherlands, which was designed to curb the ambitions of Louis XIV. This was followed by his appointment as English ambassador at the Hague, a position he held until 1670, by which time his policy of friendship with the Dutch had become unpopular with the English government. He went back to Holland as ambassador in 1674 and arranged the marriage between William of Orange and Princess Mary. Returning to England in 1679, he retired two years later from politics and in 1686 settled at Moor Park, his country house in Surrey.

Temple's literary efforts consisted chiefly of memoirs (published in two parts in 1691 and 1709), essays (published in *Miscellanea,* 1680, 1692, 1701), and a few longer pieces such as the *Essay on the Original and Nature of Government* (1672). His essay *Upon Ancient and Modern Learning* was attacked by Richard Bentley and so occasioned a famous literary quarrel, in which Temple had the spirited support of his young secretary, Jonathan Swift. Temple's essay *On Gardens,* written on a subject that was especially congenial to the author, is considered a classic in its kind. His prose, especially in his shorter compositions, is cadenced, gracious, and simple. Temple died at Moor Park on Jan. 27, 1699.

E. R. A. and T. B. S.

**TEMPLE,** a city in Bell Co., east central Texas, located near the Leon River, 35 mi. south of Waco. It was founded and incorporated in 1881 by the Gulf, Colorado and Santa Fe Railroad, which with the Missouri-Kansas-Texas Railroad provides transportation. The city of Temple has the city-manager form of government. The city's hospitals, including a veterans' facility and the Gulf, Colorado and Santa Fe hospital, are noted throughout the country. There is a junior college located in Temple. Farming is the principal pursuit of the district, and cotton, corn, and oats are the main crops. The city's industrial establishments include railroad shops and furniture, rock wool, and men's clothing factories. Pop. 1950, 25,467.

**TEMPLE** (Heb. *beth ha-mikdash*), in Jewish history, the name of the two successive central sanctuaries of the ancient Hebrews. The first of these, which is described in detail in I Kings (vi-vii) and again in II Chronicles (ii-iv), was built by Solomon in Jerusalem, on a site originally purchased by his father David (II Sam. xxiv: 18-25). Solomon's alliance with Hiram, king of Tyre, enabled him to procure Phoenician artists, builders, and materials, and the magnificent structure that resulted was the work of seven years.

According to Biblical tradition, Solomon's Temple replaced the Tabernacle as the Hebrew house of worship. The Tabernacle, minutely described in the Book of Exodus (xxv-xxviii; xxx-xxxi; xxxv-xxxix), was the portable sanctuary of the Hebrews during their sojourn in the wilderness. After their entry into Canaan, it was set up at Shiloh. There are marked similarities in the arrangement of the Tabernacle and that of the Temple, and presumably the latter was modeled on the former. In the opinion of most Bible critics, however, the reverse is probably true, for they regard the conception of the Tabernacle as a projection into the past of post-exilic ideas, and accordingly, the description of the tabernacle, which is ascribed to the priestly school of writers, reflects the impression made by the First and Second Temples. An interesting comparison may be made between the house of the Lord envisioned by Ezekiel (Ezek. xl: xlv) and the Tabernacle and the two Temples.

The appointments of Solomon's Temple were of great value, and several times during its four-hundred-year existence the Temple was plundered by enemies. Hezekiah, king of Judah, was obliged to take silver and gold from the Temple to pay tribute to the king of Assyria (II Kings xviii:13-16). In 586 B.C. the First Temple was destroyed by the Babylonians, Nebuchadnezzar carrying off its vessels to Babylon.

**Second Temple.** When the Jews returned from the Babylonian exile (536 B.C.), they erected an altar on the site of the destroyed temple and laid the foundation for the new

one, Cyrus of Persia having given permission for its erection. The work was temporarily discontinued, however, either because of outside interference (as suggested in the Book of Ezra) or because of apathy on the part of the people (as suggested in the prophetic books of Haggai and Zechariah). Work was resumed (520), apparently in obedience to the exhortations of the two prophets, and in 516 B.C. the Second Temple, also called Zerubbabel's Temple, was completed. This building, although similar in general arrangement to Solomon's Temple, could not compare with it in magnificence. During the period of the Second Temple priestly influence was strong in Jewish thought, and the temple ritual was therefore extremely elaborate. The Temple was desecrated by the Syrians under Antiochus Epiphanes in the second century B.C. and was cleansed and rededicated by Judas Maccabeus.

**Herodian Temple.** In the eighteenth year of his reign (c. 20 B.C.), King Herod set out to renovate and rebuild the Temple. He greatly enlarged the building itself and the whole surrounding area. The reconstructed building, lavishly adorned with gold and silver, was, in its time one of the most splendid edifices in the Near East. The renovation of the Temple proper was completed in a year and a half, but the work on the outer structures continued until the Temple was burned by the Romans in A.D. 70. All that remains is a portion of the western side of the outer wall that enclosed the Temple area; this wall, which gives some suggestion of former magnificence and size, is known as the Wailing Wall, and pilgrimages are made to it and prayers offered there. The hope that the Temple will be restored is part of the messianic aspirations of traditional Judaism. *See also* ARK; HANNUKAH; JERUSALEM; TISHA B'AB. M. A. G.

**TEMPLE, CLASSICAL.** In Classical antiquity the temple had a place not only in the interests of individual citizens but also in the functions of the civic body. Being an expression of the aims and resources of the state, it stimulated and conditioned some of the most characteristic manifestations of Classical architecture and its dependent arts. As thus interpreted, a temple differed in degree rather than in kind from palace sanctuaries such as those of the Bronze Age in Crete, or a house- or street-shrine with its associations with small social groups, for which abundant evidence is available from Delos and Pompeii. From another point of view, the temple represented the culmination of the urge to propitiate the supernatural energies, a consciousness of which was stimulated in primitive man by such natural landscape features as hill-tops, groves, caves, springs, and large, mysterious stones. The graves of the dead were also important centers of propitiatory ceremonies.

It was usual throughout the Greek and Roman world that the temple building proper should be treated as the shelter for the image of the Divinity, and that the act of worship should be performed outside it, at an altar that normally was placed in front of and on the axis of the sacred building. At certain sanctuaries, the Athenian Acropolis and the sacred grove of Olympia, for example, this altar lay off the axis, an indication that its foundation antedated that of the temple building itself, and by inference that it originated in an age that did not represent the divinities in human form. Most temples in Greece, and some in Roman areas, were placed in enclosures that isolated them from contact with the workaday world and within which various forms of accessories for the cult were provided. When Augustus constructed the great Temple of Mars Ultor and its "forum" in a crowded part of Rome, he observed this tradition, erecting a lofty fireproof wall, partly in a spirit of conservatism, partly from practical considerations. An important divinity, as patron and protector of the state, would naturally be housed at the summit of the citadel, as Athena on the Acropolis of Athens, and Jupiter Optimus Maximus, Juno, and Minerva on the Capitoline Hill in Rome.

The foundation, or at least the maintenance, of a temple was frequently dictated by considerations of a utilitarian character: this appears in the plainly recognizable class of "promontory-temples" that marked the principal sea routes of early times. The divinities that presided over wind and weather required propitiation along those routes; hence, there existed such well-frequented shrines as those at Sunium, the critical point for mariners approaching Athens from the east, and at the wind-dividing cape near Croton, on the route towards the western waters. Temples at health-giving springs became associated with the medical art, as at Epidaurus, Cos, and Pergamum, and the accumulation of offerings led to the local priesthood's assuming some of the functions of custodians and bankers, doubtless furthering the invention and development of coinage. A still more profound influence in the Greek world was exerted by the far-famed and revered oracular sanctuaries, such as that at Delphi, which, being frequented by pilgrims from all parts of the Greek world and the regions adjacent, placed the priesthood in possession of unrivalled information, which they used effectively, for instance, in giving advice as to the establishment of colonies in remote parts of the known world. The recurring festivals at some religious centers, such as Olympia and Delphi, brought the various branches of the Greek race together as nothing else could, and exerted incomparable influence on the arts. Athenian tragedy and comedy grew up in connection with the sanctuary of Dionysus, "the Liberator," and the other sanctuary of Dionysus "in the Marshes," for which special theatrical edifices were created. The drama, like song and dance, was a ritual act, at least in its origins and by its traditions.

In the Roman world, given the practical and administrative tendency of that people, the chief temples served the cults and the functions of the State often in a matter-of-fact way. First, the kingdom witnessed the building of the Capitoline temple, which was inaugurated in the first year of the Republic; then followed the various forms of worship of the Republic, including the dramatic representations held at the festivals; and finally, the temples became associated with the worship of the rulers, the Imperial House, and the Imperial administration. The worship of the administration became the special function of temples in the provinces; in certain regions, notably, Gaul and Britain, a contrast was afforded by nonclassical types of structure, which testify to the persistence of the traditional regional culture. In the smaller communities of the Empire, temples, like baths, afforded an opportunity to wealthy benefactors to perpetuate their names by the donation of such structures; but expenditures of this kind occurred too frequently and uniformly to have been purely spontaneous and voluntary, and in reality these benefactions, which discharged to some extent the responsibilities of whole communities, were the equivalent of a graduated tax on wealth.

The intelligence and imagination of the Greeks, Etruscans, and Romans found expression in their temples. Classical Greek temples provided for a cult statue in human form in the midst of the main room, within which it could be seen from all sides, an anthropomorphic and tridimensional figure; the Etruscans set their images against the back wall of the sanctuary, which they treated as a spiritual or metaphysical

medium to collect and send forth the waves of supernatural emanation; the Romans, again with their practical leanings even in religious matters, and with their legalistic bent towards formalization and codification, placed their temples, by preference, not in walled-off areas but at their civic centers and in direct contact with the administrative, commercial, and social activities for which they were made to function. In the Roman Forum the basement of the Temple of Saturn accommodated the state treasury, and that of the Temple of Castor and Pollux held a series of well-protected cells which appear to have served as strong rooms as well as a bureau of weights and measures, while its front was used at times as a platform for speakers, and the temple was always the rendezvous of the Roman knights. By reason of their ritually "inaugurated" status, some of these edifices were on occasion chosen for meetings of the Senate.

The Latin word *templum* has technical associations due to the tendency of the Roman mind to approach its problems through the use of formulas, whether verbal or mathematical, and through the reduction of the abstract and nebulous to the concrete and precise. It is in origin a term in augury, meaning "that which is marked off or defined." From signifying the augur's rectangular hut or tent, and the rectangular space about it, which served as starting point or base for his observations of earth and sky, it was applied to the ground, likewise rectangular, set apart by augury for a consecrated edifice, whether a shrine or an administrative building. The Roman senate-house, according to the learned Varro, contained a *templum* in the sense of a defined space within which decrees of the senate might lawfully be promulgated. Then, through association, the word was used to denote a religious edifice, first one that had been "inaugurated" by augury, then even those belonging to other categories; so that in many instances its meaning cannot be distinguished from that of *aedes* ("building"), especially in the works of the poets, for whom metrical convenience appears frequently to have determined the choice of the one word rather than the other.

The temples of classical antiquity are now represented by the actual remains, in varying degrees of preservation, of some hundred edifices in Greek lands, over seventy from Etruria or the Roman Republic, and a vast number belonging to the Roman Imperial period, in Rome itself, Italy, or the provinces. For their interpretation, much help is afforded by building inscriptions, inventories, and records of various sorts; by the technical treatise of Vitruvius, who very wisely starts his discussion by emphasizing the importance of "symmetry" and "proportion"; and by innumerable passages in literature, as well as representations on coins and in sculpture. The following account is summary and selective, but will endeavor to show the general features and broad tendencies of temple construction.

The conventional design shows the essential elements in a fully developed Greek temple: a rectangular plan and a nucleus enclosed between side walls, with columns between pilasters at one or both ends. Such a nucleus was typologically and functionally complete in itself, but in the larger structures it was usually enclosed by a colonnade. The series of temples began in the sixth century B.C. at Thermon and Sparta and reached its perfection in the Age of Pericles at Athens. Both forms and decoration were influenced by the traditional use of sun-dried brick, with wooden roofing and the protection of roof-tiles and cornices of clay. A logical ordering of the various parts was maintained throughout the centuries. Evolution was in details and refinements, and in the adoption of richer materials. In most parts of the Greek mainland, as well as in southern Italy and Sicily, the Doric order was followed; in Asia Minor, the Ionic. Ictinus, the architect of the Parthenon and the temple at Phigalia, used both, in different parts of his temples, and even introduced an early form of Corinthian column at Phigalia.

In Hellenistic times this rich, slender early form of the Corinthian column, which had certain practical advantages, achieved the vogue that it held under the late Roman Republic and the Empire. The solid, spacious, and approachable character of the Greek temple was aided by its low, stepped foundation and by its colonnade; its visual effectiveness was increased by the deep shadows cast by the colonnade and by the contrasts afforded by the simple coloring in certain upper details, especially the fields of metopes and friezes, and the cornices and eaves. It was relieved of possible monotony by various devices and subtleties, such as the adjustments in intercolumnar space necessitated at the corners of a Doric temple through the problem of the corner metopes and triglyphs; also through the delicate modifications in the contours and proportions of shaft and capital. Some of the most carefully constructed temples show slightly convex instead of horizontal surfaces, a structural and optical subtlety that surely was intended by the builders. The danger of earthquakes prompted the exercise of great pains in ensuring the stability of the foundations. The lighting of the interior was limited to the front opening. There was a tendency in practice to use the pronaos for the exhibition of votive offerings, and the opisthodome for more protected storage of similar objects. Round buildings, like those at Olympia, Delphi, and Epidaurus, while exhibiting perfection of craftsmanship, are not temples of the greater divinities.

The Etrusco-Italic temple, while making use of many of the achievements of the Greeks, was motivated by a different conception of the deity and of the use to be made of his shrine. It stood upon a lofty base; the depth of its front porch was commensurate with that of the cult room behind, and its rear wall, which frequently extended on each side beyond the lines of the side walls of the cult room, served as backing for the cult image. The main features of the Etrusco-Italic temple appear in the remains of the temple at Lanuvium in Latium. Several of these edifices have a triple cult room, like that of the Capitoline Temple in Rome. The walls and roofings of most of them were executed in perishable materials, wood and sun-dried brick, and this necessitated or encouraged the use of terra-cotta revetments, a Greek or Near Eastern device, which was here accorded a special interpretation. These edifices also reveal a distinctive treatment of the pediment, its *columen* and *mutuli* masking the ends of the main and secondary roof-beams.

The Romans, in temple building as in other matters, availed themselves of the achievements of the Greeks and of the traditions of the Etruscans and Italians, but adapted them to their own requirements. They sometimes applied the space available in the high substructure to practical ends, inserting a platform for the altar between the flights of stairs at the front. Augustus performed a great work of restoration, using the old formulas conservatively, but carrying them out in the costly white marbles of Greece and Luna (Carrara); the characteristics of his age appear in the *Maison Carrée* at Nîmes in France. Succeeding generations witnessed the development of methods of construction in brick and concrete, with facing in marble or stucco, and, in spite of occasional Classicistic revivals, a turning away from the Greek tradition in favor of a more truly national and Imperial mode of procedure. The niche at the rear of the cult room was added as a new element, and the apse was further developed. Meanwhile an independent, parallel course was run by another Italic type

of structure, the round shrine, the best-known example of which was the sanctuary of Vesta in the Roman Forum, and the most monumental expression the Pantheon as rebuilt by Hadrian. The circular shape of the sanctuary and the Pantheon appears to exclude them from the category of *templa* in the strict sense, though this word as well as *aedes* is applied by the poets to the shrine of Vesta. The Pantheon appears to stand in a class by itself with regard to its religious functions, and other round buildings may have been dedicated not to the great divinities of the celestial hierarchy but to secondary, subordinate members, such as Hercules and Portunus. With the later Empire and the influx of Oriental religions, a further shift occurred in cult requirements, and there came an urge to vastness of dimension. Concomitantly, the spread of the worship of Mithras led to the establishment of numerous diminutive shrines of that god in all parts of the Empire, and especially at frontier posts, though they are well represented at Ostia and in Rome itself. When the reign of Constantine (A.D. 307-337) brought official recognition of Christianity, a different attitude towards the divine and a different ritual found monumental expression: a new age began. A. W. Van B.

**TEMPLE UNIVERSITY,** an accredited, coeducational, privately controlled institution, partially supported by state aid. The university occupies a 71-acre campus within the city limits of Philadelphia, Pa. It was started in 1884 and was chartered four years later as Temple College. The present name was adopted in 1907, when the professional schools were added.

The degrees offered include the A.B., the B.S. in metallurgy, business administration, education, pharmacy, theology, and medical technology. The M.Ed., the M.S., the M.D., the D.D.S., the L.L.B., the M.S. and D.S. in chiropody, the M.S.T., the D.S.T., the M.A., the D.Ed., and the Ph.D. are also awarded. The divisions of the university include the College of Liberal Arts and Sciences (1888), the School of Theology (1893), the School of Law (1895), the School of Medicine (1901), the School of Pharmacy (1903), the School of Dentistry (1907), the School of Music (1913), the School of Chiropody (1915), the School of Commerce (1918), Teachers College (1919), the School of Oral Hygiene (1920), the Oak Lane Country Day School (1931), the Stella Elkins Tyler School of Fine Arts (1935), and the School of Nursing (1937). A Community College and Technical Institute has recently been established to provide for junior-college work and for a two-year vocational college to offer university facilities to business, industry, and labor unions, including management and labor service. The university library contains a collection of books printed in England prior to 1550 (film copies).

Sororities and fraternities have been established on the campus and the students are permitted to live in the chapter houses. Dormitories are available and any other housing must be approved. Scholarship assistance is very generous and a substantial fund has been established to grant loans to students. *For statistics see* COLLEGES AND UNIVERSITIES. J. R. To.

**TENAFLY** [tɛ′nəflai], a borough in Bergen Co., in northeastern New Jersey, situated on the Hudson River, 17 mi. north of Jersey City. Transportation is provided by the Erie Railroad. Tenafly is a residential community with a few light industries. The borough was founded by the early Dutch and French Huguenots, and incorporated in 1894. A mayor and council administer the local government. Pop. 1950, 9,651.

**TENANT.** *See* LANDLORD AND TENANT.

**TEN BRINK, BERNHARD AEGIDUS KONRAD.** *See* BRINK, BERNHARD AEGIDUS KONRAD TEN.

**TENCH,** *Tinca tinca,* an Old World minnow of the family Cyprinidae. Ranging through Europe, Asia Minor, and western Siberia, it inhabits weedy ponds, reservoirs, and sluggish rivers. The tench lives near the bottom and feeds on worms, insects, shellfish, and weeds. In winter hibernation, it burrows in the mud. Some of them dredged from the bottom at this time showed no life until struck several times. A very hardy fish, the tench may live a fairly long time out of water and survive periods of drought by burrowing in mud. A person, making a quiet approach and slipping the fingers under the gills, can often catch a tench by hand. Full-grown specimens reach a weight of over 12 lb. A generally discredited idea that this fish has healing powers, both for other fish and men, was formerly widely believed in Europe. E. C. R.

**TEN COMMANDMENTS.** *See* DECALOGUE.

**TENDON.** *See* MAN, FUNCTIONAL ANATOMY OF (*The Tissues; Muscular System*); MUSCLES.

**TENEBRAE** [tɛ′nɪbri] (Lat., darkness), in the Roman Catholic Church, the anticipated office of matins and lauds of the last three days of Holy Week. The gradual putting out of the lights in the Good Friday office dates probably from the fifth century, Thursday's office being said in a brightly lighted church, and Saturday's with a single candle. This extinguishing of the lights, symbolic and not simply utilitarian in origin, was extended to all three offices, which came to be regarded as a sort of solemn dirge commemorating the death of Jesus Christ. Among the texts chanted are the Lamentations of Jeremiah. Upon the unadorned altar are set six candles, and upon a hearse or harrowlike triangular frame, fifteen more. Of these fifteen, one is put out at the end of each of fourteen psalms, the six on the altar being extinguished during the *Benedictus.* The remaining lighted candle is then hidden behind the altar. The words "Christ became obedient for us unto death" are sung, Psalm 50 is recited, and a prayer said. The candle is then brought forth. The making of "a noise and clatter to some extent" originated in the master of ceremonies' signal to leave, and was later interpreted as a symbol of nature's confusion upon the death of Christ. N. J. T.

**TENEDOS** or **BOZCAADA** [tɛ′nədos, bo′zjɑɑdɑ′], a Turkish island, about 6 mi. long and 3 mi. wide, and also the chief town of that island, lying in the Aegean Sea, 3 mi. off the west coast of Asia Minor and 12 mi. south of the entrance to the Dardanelles. Because of its location, the island has a historical importance entirely disproportionate to its size. In the Trojan legend it played a prominent part as the station to which the Greeks withdrew and concealed their fleet, after leaving the wooden horse at the gates of Troy; and during the Persian wars the island was used by Xerxes as a naval base. In the Peloponnesian War, Tenedos sided with Athens, to which it paid tribute; but at the peace of Antaleidas it was surrendered to the Persians. In the time of Alexander the Great, the Tenedians revolted from Persia; and during the wars of Macedonia with the Romans the island was again an important naval station. The emperor John V Palaeologus ceded Tenedos to the Venetians in 1377, and in 1657 the island was seized by the Turks and permanently incorporated into the Turkish Empire. The popula-

tion of the island is mostly of Greek origin. Tenedos produces excellent wines and in ancient times was noted for the beauty of its women. Pop. 1950, 1,781. C. W. D.

**TENERIFE** [tɛ′nərɪf; te′neri′fe], a volcanic peak, the highest of the Canary Archipelago, on the island of Tenerife, occupying with its spurs nearly two thirds of the island. Its gullies and escarpments descend to the coast. The volcano is not extinct, though normally it is quiescent; continuous steam and sulphurous vapor issue from it. It has two craters: El Piton, about 12,192 ft., and Chahora, about 9,888 ft. The base of the cone is covered with good pasture, succeeded by chestnut, oak, and pine forests. The upper slopes are covered with slaggy lava, and the peak is snow-covered for four months of the year. A climatic vagary of the area is that the peak is often swept by a strong antitrade wind from the southwest, while the northeast trade wind is blowing at the base. In the years 1761, 1795, and 1798, great quantities of lava poured from the crater and vents in the mountain. The last serious eruption occurred in 1910.

S. Van V.

**TENGGERESE.** *See* Indonesian Peoples (*Principal Peoples*).

**TENGRI KHAN** [tɛ′ŋri χɑ′n], the highest peak in the central Tien Shan range, on the border between the Kirghiz Soviet Socialist Republic of the Soviet Union and Sinkiang. The height of the peak is estimated to be 22,940 ft. Tengri Khan is at the point where the long, high Ala Tau and Kok Chaal ranges meet. On its western side, the mountain has at least five glaciers exceeding 12 mi. in length. The longest of these is the Inyltchek Glacier, which exceeds 46 mi. in length. J. E. V.

**TENIERS, DAVID** [təni′rs] (1610-1690), called "the Younger," Flemish genre painter, was born in Antwerp in 1610, the son of the painter David Teniers "the Elder," from whom he received his first training. In 1637 he married the daughter of the painter Jan Brueghel. In 1646 he was appointed court artist and director of the picture gallery of the governor of the Netherlands, and in 1663 he founded a painting academy at Antwerp. Teniers' pictures won the high esteem of both Philip IV of Spain and Louis XIV of France, and he became the most successful and prolific genre painter of Flanders in the seventeenth century. As many as two thousand paintings have been credited to him. His earliest peasant scenes were influenced by Rubens and Brouwer, but about 1640 he developed a strong, original style, characterized by treatment of light and shade with facile brushstrokes of bright but cool colors. The quality of his work varies greatly. His importance and popularity rest on tavern and outdoor scenes of merry, salubrious peasant life, though he also depicted mythological, religious, and historical events. Teniers died in Brussels on Apr. 25, 1690. R. A. K.

**TENINO.** *See* Indian Tribes, North American (*Plateau*).

**TENITE.** *See* Plastics (*Commercial Plastics*).

**TENNESSEE,** a central southeastern state of the United States. The meaning of the word is unknown but is said to have been derived from Tannansie or Tansi, the name of the ancient capital of the Cherokee tribe, which later became the name of both the state and the Tennessee River; the name was first used in its present form in 1761. Tennessee has been known as the Volunteer State since the Mexican War, when a call was issued for 2,800 men and 30,000 volunteered. It has an area of 42,244 sq. mi., of which about 285 sq. mi. are inland water surface. It ranks thirty-third in area among the states. The state has the form of a rough parallelogram. It is bordered on the north by Kentucky, on the northeast by Virginia, on the east by North Carolina, on the southeast by Georgia, on the south by Alabama, on the southwest by Mississippi, and on the west by the Mississippi River, which separates it from Arkansas and Missouri.

Tennessee entered the Union on June 1, 1796, and was the sixteenth state to achieve statehood. Its motto is "Agriculture, Commerce." The state flower is the iris; the state bird is the mocking bird; and there are two official state songs, *My Homeland, Tennessee* and *When It's Iris Time in Tennessee.* Tennessee has ninety-five counties, and the state capital is Nashville.

## PHYSICAL FEATURES

**Topography.** The surface features of Tennessee are highly varied. They range from the rugged mountain country on its eastern border to the flat swampy plains of the Mississippi River on the west. There are roughly three grand divisions—east, middle, and west—each varying slightly in climate and agriculture. The mean elevation of the state is around 900 ft., with its highest point at Clingman's Dome, 6,642 ft., in the Great Smoky Mountains National Park of east Tennessee, and its lowest point, 190 ft., just south of Memphis on the bank of the Mississippi River.

*THE GREAT SEAL OF THE STATE OF TENNESSEE*

COURTESY OF THE TENNESSEE CONSERVATION DEPT.

The eastern border of Tennessee runs along the crest of the southern end of the Appalachian Mountains, known in this section as the Unaka Range. This range includes the Great Smoky Mountains, from which the National Park takes its name. All sections of the Unakas, outside Great Smoky Mountains National Park, make up the Cherokee National Forest. The Unakas consist of a chain of complicated and irregular crystaline ridges, and of small mountain coves. The coves are isolated, fertile valleys. The Unakas vary in width from about 2 to 15 mi., and the main peaks, which lie along the central section of the state's eastern border in Great Smoky Mountains National Park, are more than 6,000 ft. high.

This range drains into the valley of east Tennessee and the Tennessee River, which has now become a series of man-made lakes. The valley floor, varying from 30 to 60 mi. in width, is cut by a series of parallel low ridges and valleys, the ridges lying as high as 800 ft. above the general valley floor.

The eastern edge of the Cumberland Plateau is a south-

# TENNESSEE

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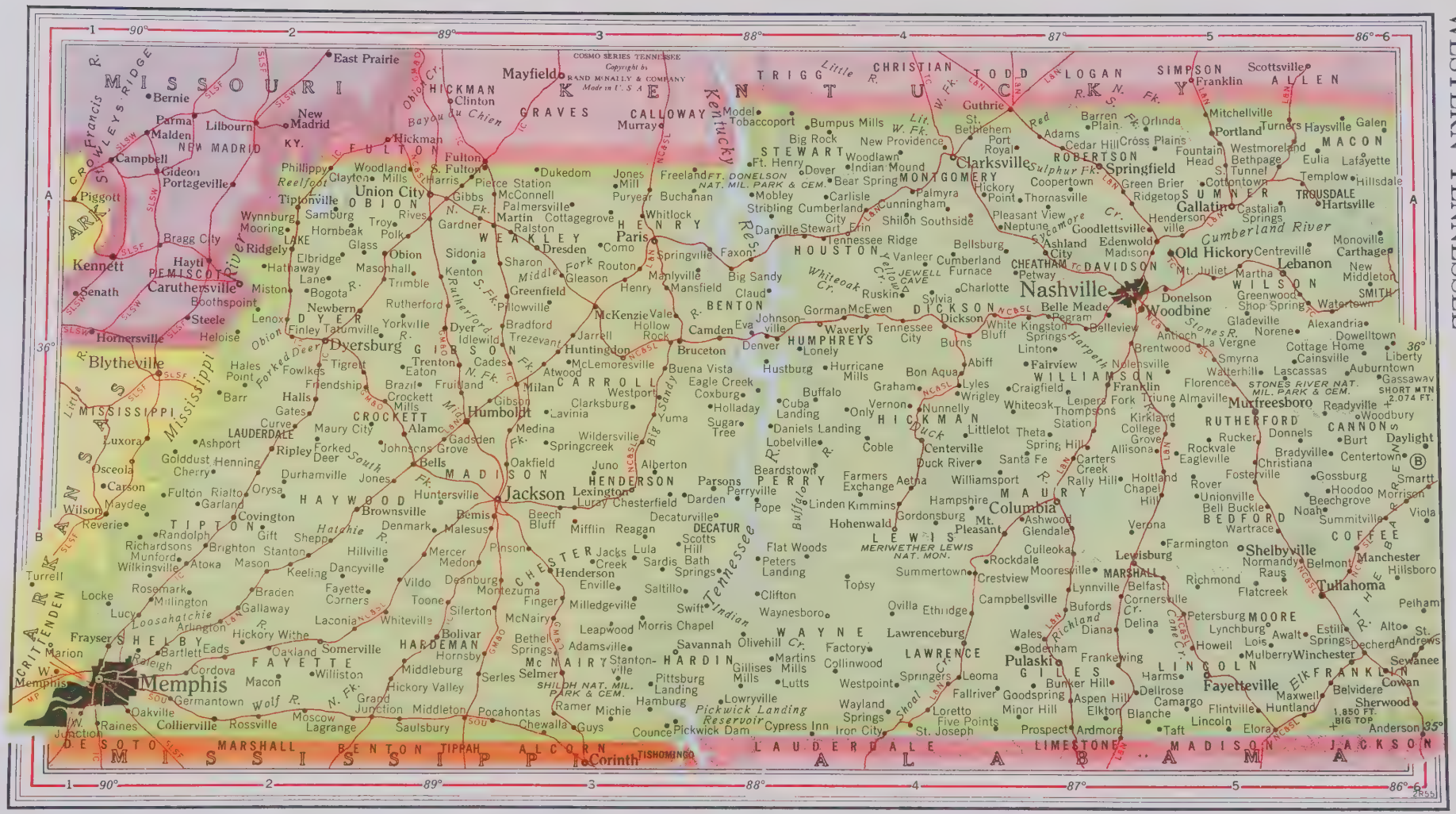
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Lebanon
Gallatin
Springfield
Old Hickory
Woodbine
Pulaski
Lewisburg
Huntland
Sherwood
Corinth
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Stones River Nat. Mil. Park & Cem.
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Natural Bridges
Jewell Cave
Short Mtn 2,074 ft.
1,850 ft. Big Top
Tennessee
Cumberland River
Mississippi
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South Fk.
Hatchie R.
Loosahatchie
Wolf R.
Big Sandy
Duck R.
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Elk R.
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Tennessee Valley Authority Hydro Plant Abandoned
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Tennessee Valley Authority Hydro Plant Leased
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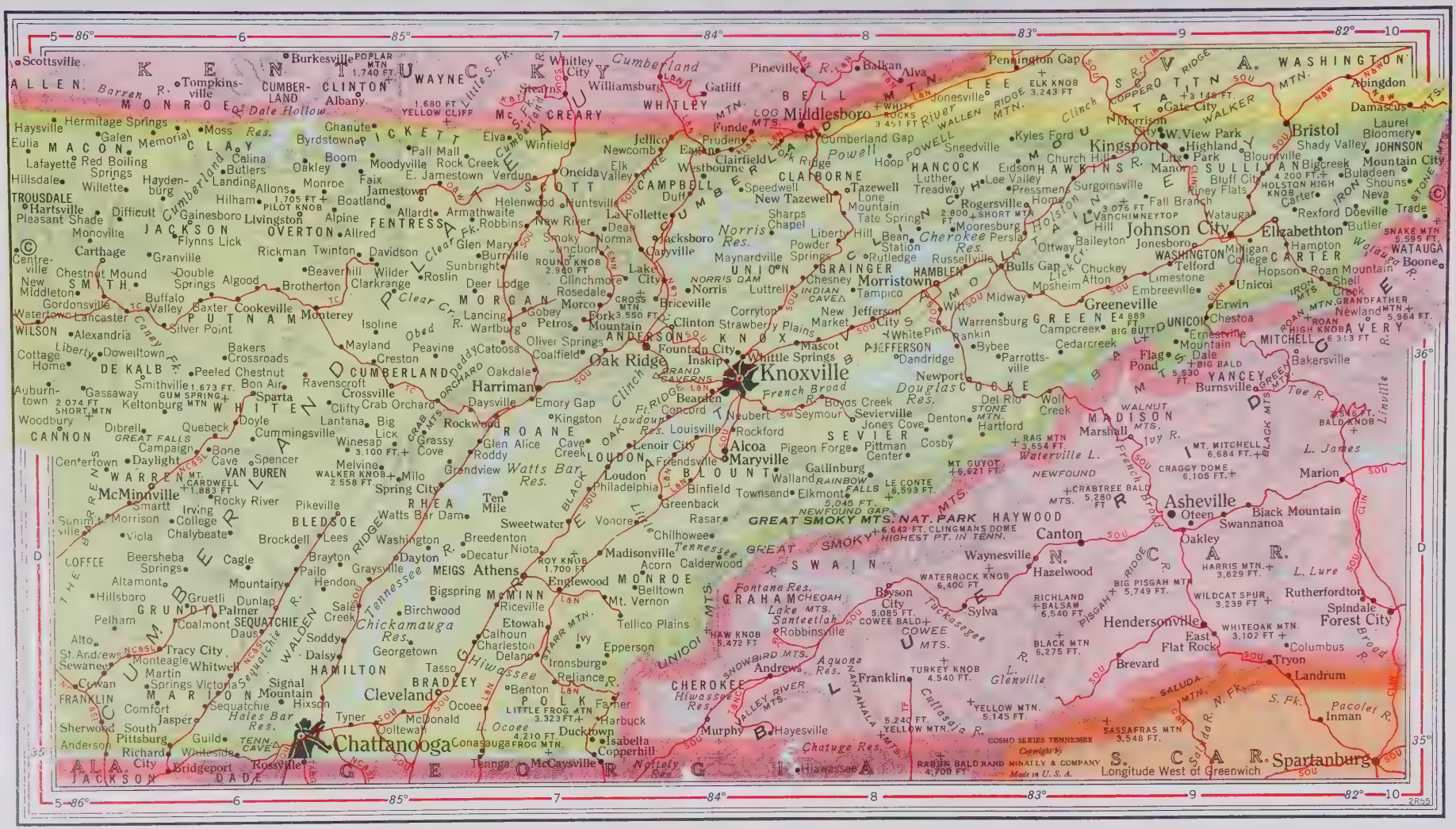
Tennessee Valley Authority Hydro Plant Operated

# EASTERN TENNESSEE





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Cowan, 1,835 . . . . B 5, D 5
Coxburg, 50 . . . . . B 3
Crab Orchard, 700 . . . . D 7
Craigfield, 100 . . . . . B 4
Creston, 170 . . . . . C 6
Crestview, 400 . . . . . B 4
Crockett Mills, 125 . . . B 2
Cross Plains, 175 . . . . . A 5
Crossville, 2,291 . . . . . D 6
Cuba Landing, 240 . . . . B 4
Culleoka, 400 . . . . . B 5
Cumberland City, 400 . . A 4
Cumberland Furnace, 250 . . . . A 4
Cumberland Gap, 403 . . C 8
Cummingsville, 50 . . . . D 6
Cunningham, 131 . . . . . A 4
Curve, 200 . . . . . B 2
Cypress Inn, 300 . . . . . B 4
Daisy, 1,336 . . . . . D 6
Dancyville, 75 . . . . . B 2
Dandridge, 690 . . . . . C 8
Daniels Landing, 27 . . . B 4
Danville, 50 . . . . . A 4
Darden, 200 . . . . . B 3
Daus, 175 . . . . . D 6
Davidson, 200 . . . . . C 6
Daylight, 1,200 . . . B 6, D 8
Daysville, 130 . . . . . D 7
Dayton, 3,191 . . . . . D 7
Dean, 300 . . . . . C 7
Deanburg, 56 . . . . . B 3
Decatur, 235 . . . . . D 7
Decaturville, 514 . . . . . B 3
Decherd, 1,435 . . . . . B 5
Doyle, 600 . . . . . D 6
Dresden, 1,509 . . . . . A 4
Duck River, 200 . . . . . B 4
Ducktown, 1,064 . . . . . D 7
Duff, 200 . . . . . C 7
Dukedom, 125 . . . . . A 2
Dunlap, 873 . . . . . D 6
Durhamville, 50 . . . . . B 2
Dyer, 1,864 . . . . . A 3
Dyersburg, 10,885 . . . . A 2
Eads, 250 . . . . . B 2
Eagan, 1,000 . . . . . C 8
Eagle Creek, 150 . . . . . B 4
Dowelltown, 262 . . A 6, C 6
Donelson, 1,765 . . . . . A 5
Donnels, 58 . . . . . B 5
Double Springs, 250 . . . C 6
Dover, 1,500 . . . . . A 4

# TENNESSEE *Continued*

Eagleville, 378 . . . . . B 5
East Jamestown, 150 . . . C 7
Eaton, 175 . . . . . B 2
Edenwold, 300 . . . . . A 5
Edson, 251 . . . . . C 8
Elbridge, 95 . . . . . A 2
Elizabethton, 10,754 . . . C 9
Elkmont, 50 . . . . . D 8
Elkton, 168 . . . . . B 5
Elk Valley, 600 . . . . . C 7
Elora, 520 . . . . . B 5
Embreeville, 609 . . . . . C 9
Emory Gap, 500 . . . . . D 7
Englewood, 1,545 . . . . . D 7
Enville, 300 . . . . . B 3
Epperson, 500 . . . . . D 7
Erin, 858 . . . . . A 4
Ernestville, 200 . . . . . C 9
Erwin, 3,387 . . . . . C 9
Estill Springs, 496 . . . . . B 5
Ethridge, 500 . . . . . B 4
Etowah, 3,261 . . . . . D 7
Eulia, 65 . . . . . A 5, C 5
Eva, 250 . . . . . A 3
Factory, 60 . . . . . B 4
Fairview, 1,300 . . . . . B 4
Fall Branch, 1,000 . . . . . C 9
Farmers Exchange, 166 . . B 4
Farmington, 150 . . . . . B 5
Farner, 300 . . . . . D 7
Faxon, 128 . . . . . A 3
Fayette Corners, 70 . . . . B 2
Fayetteville, 5,447 . . . . . B 5
Finger, 250 . . . . . B 3
Finley, 800 . . . . . A 2
Five Points, 100 . . . . . B 4
Flag Pond, 475 . . . . . C 9
Flatcreek, 150 . . . . . B 5
Flat Woods, 150 . . . . . B 4
Flintville, 500 . . . . . B 5
Flynns Lick, 50 . . . . . C 6
Forked Deer, 100 . . . . . B 2
Fork Mountain, 700 . . . . C 7
Fork Ridge, 700 . . . . . C 8
Fosterville, 311 . . . . . B 5
Fountain City, 15,000 . . . C 8
Fountain Head, 350 . . . . A 5
Fowlkes, 300 . . . . . B 2
Frankewing, 85 . . . . . B 5
Franklin, 5,475 . . . . . B 5
Frayser, 4,500 . . . . . B 1
Freeland, 50 . . . . . A 3
Friendship, 452 . . . . . B 2
Friendsville, 600 . . . . . D 7
Fruitland, 350 . . . . . B 3
Fulton, 75 . . . . . B 2
Gaasden, 255 . . . . . B 3
Gainesboro, 992 . . . . . C 6
Galen, 100 . . . . . A 6, C 6
Gallatin, 5,107 . . . . . A 5
Galloway, 175 . . . . . B 2
Gardner, 250 . . . . . A 3
Garland, 157 . . . . . B 2
Gassaway, 101 . . . . B 6, D 6
Gates, 234 . . . . . B 2
Gatlinburg, 1,301 . . . . . D 8
Georgetown, 65 . . . . . D 7
Germantown, 408 . . . . . B 2
Gibbs, 75 . . . . . A 3
Gibson, 308 . . . . . B 3
Gillises Mills, 100 . . . . . B 3
Gladeville, 120 . . . . . A 5
Glass, 50 . . . . . A 2
Gleason, 1,063 . . . . . A 3
Glen Alice, 250 . . . . . D 7
Glen Mary, 300 . . . . . C 7
Gobey, 513 . . . . . C 7
Goladust, 125 . . . . . B 2
Goodlettsville, 1,590 . . . A 5
Goodspring, 200 . . . . . B 4
Gordonsburg, 315 . . . . . B 4
Gordonsville, 304 . . . . . C 6
Gorman, 215 . . . . . A 4
Gossburg, 250 . . . . . B 5
Grand Junction, 477 . . . B 2
Grandview, 300 . . . . . D 7
Graham, 100 . . . . . B 4
Granville, 139 . . . . . C 6
Grassy Cove, 150 . . . . . D 7
Graysville, 820 . . . . . D 6
Greenback, 1,500 . . . . . D 7
Green Brier, 890 . . . . . A 5
Greeneville, 8,721 . . . . C 9
Greenfield, 1,706 . . . . . A 3
Gruetli, 600 . . . . . D 6
Guild, 400 . . . . . D 6
Guys, 200 . . . . . B 3
Hales Point, 60 . . . . . B 2
Halls, 1,808 . . . . . B 2
Hamburg, 250 . . . . . B 3
Hampshire, 106 . . . . . B 4
Hampton, 1,164 . . . . . C 9
Harbuck, 125 . . . . . D 7
Harms, 80 . . . . . B 5
Harriman, 6,389 . . . . . D 7
Harris, 200 . . . . . A 3
Hartford, 300 . . . . . D 8
Hartsville, 1,130 . . . A 5, C 5
Haydenburg, 87 . . . . . C 6
Haysville, 150 . . . . A 5, C 5
Heienwood, 500 . . . . . C 7
Heloise, 160 . . . . . A 2
Henderson, 2,532 . . . . . B 3
Hendersonville, 800 . . . . A 5
Hendon, 200 . . . . . D 6
Henning, 493 . . . . . B 2
Henry, 200 . . . . . A 3
Hermitage Springs, 200 . . C 6
Hickory Point, 50 . . . . . A 4
Hickory Valley, 1,000 . . . B 2
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Highland Park, 4,846 . . . C 9
Hilham, 177 . . . . . C 6
Hillsboro, 150 . . . B 6, D 6
Hillsdale, 500 . . . A 5, C 5
Hillville, 200 . . . . . B 2
Hixson, 625 . . . . . D 6
Hohenwald, 1,703 . . . . . B 4
Holladay, 150 . . . . . B 3
Hollow Rock, 397 . . . . . A 3
Holtland, 150 . . . . . B 5
Hoodoo, 100 . . . . . B 5
Hoon, 300 . . . . . C 8
Hornbeak, 309 . . . . . A 2
Hornsby, 280 . . . . . B 3
Howell, 125 . . . . . B 5
Humboldt, 7,426 . . . . . B 3
Huntersville, 100 . . . . . B 3
Huntingdon, 2,043 . . . . . A 3
Huntland, 285 . . . . . B 5
Huntsville, 1,500 . . . . . C 7
Hurricane Mills, 625 . . . . B 4
Hustburg, 149 . . . . . B 4
Idlewild, 400 . . . . . A 3
Indian Mound, 325 . . . . . A 4
Inskip, 1,500 . . . . . C 8
Iron City, 850 . . . . . B 4
Ironsburg, 50 . . . . . D 7
Irving College, 100 . . . . D 6
Isabella, 2,000 . . . . . D 7
Isoline, 150 . . . . . C 6
Jacksboro, 577 . . . . . C 7
Jacks Creek, 150 . . . . . B 3
Jackson, 30,207 . . . . . B 3
Jamestown, 2,115 . . . . . C 7
Jarrell, 40 . . . . . A 3
Jasper, 1,198 . . . . . D 6
Jefferson City, 3,633 . . . C 8
Jellico, 1,556 . . . . . C 7
Johnson City, 27,864 . . . C 9
Johnsons Grove, 50 . . . . B 2
Johnsonville, 50 . . . . . A 4
Jones, 150 . . . . . B 2
Jonesboro, 1,126 . . . . . C 9
Jones Cove, 100 . . . . . D 8
Jones Mill, 50 . . . . . A 3
Juno, 100 . . . . . B 3
Keeling, 40 . . . . . B 2
Keltonburg, 100 . . . . . D 6
Kenton, 899 . . . . . A 2
Kimmins, 150 . . . . . B 4
Kingsport, 19,571 . . . . . C 9
Kingston, 1,627 . . . . . D 7
Kingston Springs, 250 . . . A 4
Kirkland, 150 . . . . . B 5
Knoxville, 124,769 . . . . D 8
Kyles Ford, 91 . . . . . C 8
Laconia, 50 . . . . . B 2
Lafayette, 1,195 . . . A 5, C 5
La Follette, 5,797 . . . . . C 7
La Grange, 241 . . . . . B 2
Lake City, 1,827 . . . . . C 7
Lancaster, 250 . . . . . C 6
Lancing, 250 . . . . . C 7
Lantana, 130 . . . . . D 6
Lascassas, 150 . . . . . B 5
Laurel Bloomery, 110 . . C 10
La Vergne, 250 . . . . . A 5
Lavinia, 100 . . . . . B 3
Lawrenceburg, 5,442 . . . B 4
Leapwood, 123 . . . . . B 3
Lebanon, 7,913 . . . . . A 5
Lees, 50 . . . . . D 6
Lee Valley, 80 . . . . . C 8
Leipers Fork, 200 . . . . . B 5
Lenoir City, 5,159 . . . . D 7
Lenox, 544 . . . . . A 2
Leoma, 350 . . . . . B 4
Lewisburg, 5,164 . . . . . B 5
Lexington, 3,566 . . . . . B 3
Liberty, 314 . . . . . A 6, C 6
Liberty Hill, 300 . . . . . C 8
Limestone, 450 . . . . . C 9
Lincoln, 120 . . . . . B 5
Linden, 854 . . . . . B 4
Linton, 150 . . . . . A 4
Littlelot, 73 . . . . . B 4
Litz Manor, 1,500 . . . . C 9
Livingston, 2,082 . . . . . C 6
Lobelville, 450 . . . . . B 4
Locke, 100 . . . . . B 1
Lois, 100 . . . . . B 5
Lone Mountain, 175 . . . C 8
Loretto, 706 . . . . . B 4
Loudon, 3,567 . . . . . D 7
Louisville, 200 . . . . . D 7
Lowryville, 75 . . . . . B 3
Lucy, 300 . . . . . B 2
Lula, 125 . . . . . B 3
Luray, 200 . . . . . B 3
Luttrell, 570 . . . . . C 8
Lutts, 350 . . . . . B 4
Lyles, 500 . . . . . B 4
Lynchburg, 401 . . . . . B 5
Lynnville, 356 . . . . . B 4
McConnell, 50 . . . . . A 3
McDonald, 200 . . . . . D 7
McEwen, 710 . . . . . A 4
McKenzie, 3,774 . . . . . A 3
McLemoresville, 242 . . . B 3
McMinnville, 7,577 . . . . D 6
McNairy, 100 . . . . . B 3
Macon, 250 . . . . . B 2
Madison, 2,992 . . . . . A 5
Madisonville, 1,487 . . . . D 7
Malesus, 125 . . . . . B 3
Manchester, 2,341 . . . . . B 5
Manlyville, 50 . . . . . A 3
Mansfield, 175 . . . . . A 3
Martin, 4,082 . . . . . A 3
Martins Mills, 70 . . . . . B 4
Maryville, 7,742 . . . . . D 8
Mascot, 987 . . . . . C 8
Mason, 414 . . . . . B 2
Masonhall, 184 . . . . . A 2
Maury City, 553 . . . . . B 2
Maxwell, 250 . . . . . B 5
Maydee, 100 . . . . . B 2
Mayland, 600 . . . . . C 6
Maynardville, 300 . . . . C 8
Medina, 690 . . . . . B 3
Medon, 115 . . . . . B 3
Melvine, 100 . . . . . D 6
Memorial, 100 . . . . . C 6
Memphis, 396,000 . . . . . B 1
Mercer, 350 . . . . . B 2
Michie, 110 . . . . . B 3
Middleburg, 250 . . . . . B 2
Midaleton, 362 . . . . . B 3
Midway, 500 . . . . . C 9
Mifflin, 125 . . . . . B 3
Milan, 4,938 . . . . . B 3
Milleageville, 325 . . . . . B 3
Milligan College, 213 . . . C 9
Millington, 4,696 . . . . . B 2
Milo, 300 . . . . . D 7
Minor Hill, 800 . . . . . B 4
Miston, 350 . . . . . A 2
Mitchellville, 202 . . . . . A 5
Model, 100 . . . . . A 4
Monoville, 300 . . . . . C 6
Monroe, 69 . . . . . C 6
Monteagle, 691 . . . . . D 6
Monterey, 2,043 . . . . . C 6
Montezuma, 200 . . . . . B 3
Moodyville, 425 . . . . . C 6
Mooresburg, 1,600 . . . . C 8
Mooring, 100 . . . . . A 2
Morco, 1,000 . . . . . C 7
Morris Chapel, 140 . . . . B 3
Morrison, 301 . . . . B 6, D 6
Morrison City-Lynn Garden-West View-Fort Robinson, 8,627 . . . . C 11
Morristown, 13,019 . . . . C 8
Moscow, 394 . . . . . B 2
Mosheim, 300 . . . . . C 9
Moss, 250 . . . . . C 6
Mountain City, 1,405 . . . C 10
Mountain Dale, 500 . . . . C 9
Mountairy, 56 . . . . . D 6
Mount Juliet, 650 . . . . . A 5
Mount Pleasant, 2,931 . . . B 4
Mount Vernon, 600 . . . . D 7
Mulberry, 200 . . . . . B 5
Munford, 976 . . . . . B 2
Murfreesboro, 13,052 . . . B 5
Nashville, 174,307 . . . . A 5
Neptune, 75 . . . . . A 4
Neubert, 600 . . . . . D 8
Neva, 65 . . . . . C 10
Newaern, 1,734 . . . . . A 2
Newcomb, 510 . . . . . C 7
New Market, 800 . . . . C 8
New Middleton, 275 . . . . . A 5, C 5
Newport, 3,892 . . . . . D 8
New Providence, 1,825 . . . . . A 4
New River, 300 . . . . . C 7
New Tazewell, 1,400 . . . C 8
Niota, 956 . . . . . D 7
Noah, 50 . . . . . B 5
Nolensville, 400 . . . . . B 5
Norene, 100 . . . . . A 5
Norma, 250 . . . . . C 7
Normandy, 159 . . . . . B 5
Norris, 1,134 . . . . . C 7
Nunnelly, 520 . . . . . B 4
Oakdale, 718 . . . . . D 7
Oakfield, 107 . . . . . B 3
Oakland, 236 . . . . . B 2
Oakley, 50 . . . . . C 6
Oak Ridge, 30,229 . . . . C 7
Oakville, 2,500 . . . . . B 2
Obion, 1,212 . . . . . A 2
Ocoee, 500 . . . . . D 7
Old Hickory, 9,000 . . . . A 5
Olivehill, 140 . . . . . B 3
Oliver Springs, 1,089 . . . C 7
Oneida, 1,304 . . . . . C 6
Only, 50 . . . . . B 4
Ooltewah, 800 . . . . . D 6
Orlinda, 515 . . . . . A 5
Orysa, 75 . . . . . B 2
Ottway, 100 . . . . . C 9
Ovilla, 50 . . . . . B 4
Pall Mall, 125 . . . . . C 7
Palmer, 871 . . . . . D 6
Palmersville, 120 . . . . . A 3
Palmyra, 175 . . . . . A 4
Paris, 8,826 . . . . . A 3
Parrottsville, 115 . . . . . C 8
Parsons, 1,640 . . . . . B 3
Peavine, 70 . . . . . C 7
Peeled Chestnut, 75 . . . . D 6
Pegram, 360 . . . . . A 4
Pelham, 150 . . . . . B 6, D 6
Perryville, 500 . . . . . B 3
Persia, 150 . . . . . C 8
Petersburg, 497 . . . . . B 5
Petros, 1,109 . . . . . C 7
Petway, 40 . . . . . A 4
Philadelphia, 490 . . . . . D 7
Phillippy, 200 . . . . . A 2
Pickwick Dam, 175 . . . . B 3
Pierce Station, 100 . . . . A 3
Pigeon Forge, 800 . . . . . D 8
Pikeville, 882 . . . . . D 6
Pillowville, 100 . . . . . A 3
Piney Flats, 300 . . . . . C 9
Pinson, 300 . . . . . B 3
Pittman Center, 200 . . . . D 8
Pittsburg Landing, 114 . . B 3
Pleasant Shade, 150 . . . C 6
Pleasant View, 150 . . . . A 4
Pocahontas, 300 . . . . . B 3
Polk, 135 . . . . . A 2
Portland, 1,660 . . . . . A 5
Powder Springs, 200 . . . C 8
Pressmens Home, 400 . . . C 8
Prospect, 450 . . . . . B 4
Pruden, 500 . . . . . C 8
Pulaski, 5,762 . . . . . B 4
Puryear, 430 . . . . . A 3
Quebeck, 250 . . . . . D 6
Raines, 300 . . . . . B 1
Raleigh, 300 . . . . . B 2
Ramer, 525 . . . . . B 3
Randolph, 125 . . . . . B 2
Rasar, 180 . . . . . D 8
Raus, 50 . . . . . B 5
Ravenscroft, 200 . . . . . D 6
Readyville, 125 . . . . . B 5
Reagan, 65 . . . . . B 3
Red Boiling Springs, 1,400 . . . . . C 6
Reliance, 400 . . . . . D 7
Reverie, 300 . . . . . B 2
Rexford, 200 . . . . . C 9
Riceville, 500 . . . . . D 7
Richard City, 300 . . . . . D 6
Richardsons, 75 . . . . . B 2
Rickman, 275 . . . . . C 6
Ridgely, 1,504 . . . . . A 2
Ridgetop, 354 . . . . . A 5
Ripley, 3,318 . . . . . B 2
Rives, 413 . . . . . A 2
Roan Mountain, 1,200 . . . C 9
Robbins, 800 . . . . . C 7
Rock Creek, 100 . . . . . C 7
Rockdale, 100 . . . . . B 4
Rockford, 950 . . . . . D 8
Rockvale, 290 . . . . . B 5
Rockwood, 4,272 . . . . . D 7
Roddy, 75 . . . . . D 7
Rogersville, 2,545 . . . . C 8
Rosedale, 150 . . . . . C 7
Rosemark, 250 . . . . . B 2
Roslin, 311 . . . . . C 7
Rossville, 175 . . . . . B 2
Routon, 40 . . . . . A 3
Rover, 125 . . . . . B 5
Ruskin, 50 . . . . . A 4
Russellville, 300 . . . . . C 8
Rutherford, 994 . . . . . A 3
Rutledge, 518 . . . . . C 8
St. Andrews, 200 . . B 6, D 6
St. Bethlehem, 200 . . . . A 4
St. Joseph, 500 . . . . . B 4
Sale Creek, 742 . . . . . D 6
Saltillo, 500 . . . . . B 3
Samburg, 378 . . . . . A 2
Santa Fe, 250 . . . . . B 4
Sardis, 299 . . . . . B 3
Saulsbury, 143 . . . . . B 2
Savannah, 1,698 . . . . . B 3
Scotts Hill, 299 . . . . . B 3
Selmer, 1,759 . . . . . B 3
Sequatchie, 395 . . . . . D 6
Serles, 100 . . . . . B 3
Sevierville, 1,620 . . . . . D 8
Sewanee, 1,407 . . . B 6, D 6
Seymour, 147 . . . . . D 8
Shady Valley, 1,300 . . . C 10
Sharon, 880 . . . . . A 3
Shelbyville, 9,456 . . . . . B 5
Shell Creek, 300 . . . . . C 9
Shepp, 100 . . . . . B 2
Sherwood, 1,300 . . B 6, D 6
Shiloh, 80 . . . . . A 4
Shop Spring, 150 . . . . . A 5
Shouns, 250 . . . . . C 10
Sidonia, 200 . . . . . A 3
Signal Mountain, 1,786 . . D 6
Silerton, 121 . . . . . B 3
Silver Point, 200 . . . . . C 6
Smartt, 300 . . . . . B 6, D 6
Smithville, 1,558 . . . . . D 6
Smoky Junction, 150 . . . C 7
Smyrna, 1,544 . . . . . B 5
Sneedville, 400 . . . . . C 8
Soddy, 2,157 . . . . . D 6
Somerville, 1,760 . . . . . B 2
South Fulton, 2,119 . . . . A 3
South Pittsburgh, 2,573 . . D 6
Southside, 75 . . . . . A 4
South Tunnel, 200 . . . . A 5
Sparta, 4,299 . . . . . D 6
Speedwell, 50 . . . . . C 8
Spencer, 721 . . . . . D 6
Spring City, 1,725 . . . . . D 7
Springcreek, 100 . . . . . B 3
Springers, 100 . . . . . B 4
Springfield, 6,506 . . . . A 5
Spring Hill, 541 . . . . . B 5
Stanton, 503 . . . . . B 2
Stantonville, 250 . . . . . B 3
Stewart, 500 . . . . . A 4
Strawberry Plains, 400 . . . . . C 8
Stribling, 100 . . . . . A 4
Sugar Tree, 100 . . . . . B 3
Summertown, 250 . . . . . B 4
Summitville, 400 . . . B 6, D 6
Sunbright, 600 . . . . . C 7
Surgoinsville, 900 . . . . C 9
Sweetwater, 4,199 . . . . . D 6
Swift, 50 . . . . . B 3
Sylvia, 152 . . . . . A 4
Taft, 210 . . . . . B 5
Tampico, 140 . . . . . C 8
Tasso, 125 . . . . . D 7
Tate Spring, 60 . . . . . C 8
Tazewell, 800 . . . . . C 8
Telford, 250 . . . . . C 9
Tellico Plains, 833 . . . . . D 7
Templow, 60 . . . . . A 5
Ten Mile, 200 . . . . . D 7
Tennessee City, 175 . . . A 4
Tennessee Ridge, 275 . . . A 4
Theta, 250 . . . . . B 4
Thomasville, 40 . . . . . A 4
Thompsons Station, 206 . . B 5
Tigrett, 400 . . . . . B 2
Tiptonville, 1,953 . . . . . A 2
Tobaccoport, 75 . . . . . A 4
Toone, 231 . . . . . B 3
Topsy, 75 . . . . . B 4
Townsend, 328 . . . . . D 8
Tracy City, 1,414 . . . . . D 6
Trade, 225 . . . . . C 10
Treadway, 73 . . . . . C 8
Trenton, 3,868 . . . . . B 3
Trezevant, 765 . . . . . A 3
Trimble, 674 . . . . . A 2
Triune, 150 . . . . . B 5
Troy, 593 . . . . . A 2
Tullahoma, 7,562 . . . . . B 5
Turners, 50 . . . . . A 5
Twinton, 150 . . . . . C 6
Tyner, 500 . . . . . D 6
Unicoi, 522 . . . . . C 9
Union City, 7,665 . . . . . A 2
Unionville, 100 . . . . . B 5
Vale, 100 . . . . . A 3
Vanleer, 243 . . . . . A 4
Verdun, 150 . . . . . C 7
Vernon, 180 . . . . . B 4
Verona, 75 . . . . . B 5
Victoria, 300 . . . . . D 6
Vildo, 100 . . . . . B 2
Viola, 223 . . . . . B 6, D 6
Vonore, 400 . . . . . D 7
Wales, 75 . . . . . B 4
Walland, 400 . . . . . D 8
Walterhill, 300 . . . . . B 5
Warrensburg, 200 . . . . . C 8
Wartburg, 800 . . . . . C 7
Wartrace, 545 . . . . . B 5
Washington, 300 . . . . . D 7
Watauga, 900 . . . . . C 9
Watertown, 933 . . . A 5, C 5
Watts Bar Dam, 135 . . . . D 7
Waverly, 1,318 . . . . . A 4
Wayland Springs, 1,892 . . B 4
Waynesboro, 1,147 . . . . B 4
Westbourne, 600 . . . . . C 7
West Junction, 800 . . . . B 1
Westmoreland, 784 . . . . A 5
Westpoint, 355 . . . . . B 4
Westport, 162 . . . . . B 3
West View Park, 3,000 . . C 9
White Bluff, 506 . . . . . A 4
White Pine, 780 . . . . . C 8
Whiteside, 522 . . . . . D 6
Whiteville, 794 . . . . . B 2
Whitlock, 130 . . . . . A 3
Whittle Springs, 1,500 . . C 8
Whitwell, 1,586 . . . . . D 6
Wilcer, 658 . . . . . C 6
Wildersville, 300 . . . . . B 3
Wilkinsville, 100 . . . . . B 2
Willette, 75 . . . . . C 6
Williston, 200 . . . . . B 2
Winchester, 3,974 . . . . . B 5
Winfield, 325 . . . . . C 7
Witt, 50 . . . . . C 8
Wolf Creek, 60 . . . . . D 9
Woodbine, 8,180 . . . . . A 5
Woodbury, 1,000 . B 5, D 5
Worley, 300 . . . . . E 8
Wrigley, 733 . . . . . B 4
Wynnburg, 250 . . . . . A 2
Yorkville, 225 . . . . . A 2
Yuma, 200 . . . . . B 3

## COUNTIES

Anderson, 59,407 . . . . . C 7
Bedford, 23,627 . . . . . B 5
Benton, 11,495 . . . . . A 3
Bledsoe, 8,561 . . . . . D 6
Blount, 54,691 . . . . . D 8
Bradley, 32,338 . . . . . D 7
Campbell, 34,369 . . . . . C 7
Cannon, 9,174 . . . B 5, D 5
Carroll, 26,553 . . . . . B 3
Carter, 42,432 . . . . . C 9
Cheatham, 9,167 . . . . . A 4
Chester, 11,149 . . . . . B 3
Claiborne, 24,788 . . . . . C 8
Clay, 8,701 . . . . . C 6
Cocke, 22,991 . . . . . D 8
Coffee, 23,049 . . . B 5, D 5
Crockett, 16,624 . . . . . B 2
Cumberland, 18,877 . . . D 6
Davidson, 321,758 . . . . . A 5
Decatur, 9,442 . . . . . B 3
De Kalb, 11,680 . . . . . D 6
Dickson, 18,805 . . . . . A 4
Dyer, 33,473 . . . . . A 2
Fayette, 27,535 . . . . . B 2
Fentress, 14,917 . . . . . C 7
Franklin, 25,431 . . . B 5, D 5
Gibson, 48,132 . . . . . A 3
Giles, 26,961 . . . . . B 4
Grainger, 13,086 . . . . . C 8
Greene, 41,048 . . . . . C 9
Grundy, 12,558 . . . . . D 6
Hamblen, 23,976 . . . . . C 8
Hamilton, 208,255 . . . . . D 6
Hancock, 9,116 . . . . . C 8
Hardeman, 23,311 . . . . . B 2
Hardin, 16,908 . . . . . B 3
Hawkins, 30,494 . . . . . C 9
Haywood, 26,212 . . . . . B 2
Henderson, 17,173 . . . . . B 3
Henry, 23,828 . . . . . A 3
Hickman, 13,353 . . . . . B 4
Houston, 5,318 . . . . . A 4
Humphreys, 11,030 . . . . . A 4
Jackson, 12,348 . . . . . C 6
Jefferson, 19,667 . . . . . C 8
Johnson, 12,278 . . . . . C 10
Knox, 223,007 . . . . . C 8
Lake, 11,655 . . . . . A 2
Lauderdale, 25,047 . . . . . B 2
Lawrence, 28,818 . . . . . B 4
Lewis, 6,078 . . . . . B 4
Lincoln, 25,624 . . . . . B 5
Loudon, 23,182 . . . . . D 7
McMinn, 32,024 . . . . . D 7
McNairy, 20,390 . . . . . B 3
Macon, 13,599 . . . A 5, C 5
Madison, 60,128 . . . . . B 3
Marion, 20,520 . . . . . D 6
Marshall, 17,768 . . . . . B 5
Maury, 40,368 . . . . . B 4
Meigs, 6,080 . . . . . D 7
Monroe, 24,513 . . . . . D 7
Montgomery, 44,186 . . . . A 4
Moore, 3,948 . . . . . B 5
Morgan, 15,727 . . . . . C 7
Obion, 29,056 . . . . . A 2
Overton, 17,566 . . . . . C 6
Perry, 6,462 . . . . . B 4
Pickett, 5,093 . . . . . C 6
Polk, 14,074 . . . . . D 7
Putnam, 29,869 . . . . . C 6
Rhea, 16,041 . . . . . D 7
Roane, 31,665 . . . . . D 7
Robertson, 27,024 . . . . . A 5
Rutherford, 40,696 . . . . B 5
Scott, 17,362 . . . . . C 7
Sequatchie, 5,685 . . . . D 6
Sevier, 23,375 . . . . . D 8
Shelby, 482,393 . . . . . B 2
Smith, 14,098 . . . . A 5, C 6
Stewart, 9,175 . . . . . A 4
Sullivan, 95,063 . . . . . C 9
Sumner, 33,533 . . . . . A 5
Tipton, 29,782 . . . . . B 2
Trousdale, 5,520 . . . A 5, C 5
Unicoi, 15,886 . . . . . C 9
Union, 8,670 . . . . . C 8
Van Buren, 3,985 . . . . . D 6
Warren, 22,271 . . . . . D 6
Washington, 59,971 . . . . C 9
Wayne, 13,864 . . . . . B 4
Weakley, 27,962 . . . . . A 3
White, 16,204 . . . . . D 6
Williamson, 24,307 . . . B 5
Wilson, 26,318 . . . A 5, C 5

ward continuation of the Allegheny Front, rising about 1,000 ft. above the level of the east Tennessee valley. The southern portion of this eastern face, known as Walden Ridge, is sharp and abrupt. The upland surface of the plateau has an elevation of about 2,000 ft. and is somewhat dissected, in the south by the Sequatchie Valley and in the north by many deep, narrow valleys separated by sharp dividing ridges. The western escarpment of the plateau is also generally precipitous.

The Highland Rim bounds the Cumberland Plateau on the west and lies about 1,000 ft. below it. The Rim is part of an old dome which has been eroded in its central portion, exposing an area known as the Nashville Basin. Its inward margin, fronting on the basin, is sharply dissected by stream erosion, and the fringe is known as the Knobs.

The Nashville Basin, which lies about 400 ft. below the general level of the Rim, is a fertile limestone region extending nearly the entire breadth of the state from northeast to southwest. It is about 120 mi. long and 60 mi. wide.

The Plain of Western Tennessee comprises the broad region west of the Highland Rim. It includes the western valley of what is now Tennessee-Kentucky Lake, the largest man-made body of water in the world. Also included is the Jackson Plain, stretching westward to the Mississippi River. The Jackson Plain is a rolling region moderately dissected by sluggish streams. It ends abruptly on the west in a line of low bluffs, cut by the Mississippi in its meanderings across its flood plain.

The Mississippi Bottomlands comprise a narrow strip of flood plain extending from the western limits of the Jackson Plain to the Mississippi River itself. This region, consisting of low swampy plains, varies in width with the bends of the river and contains many small lakes and ponds. Reelfoot Lake is close to the northwestern border of the state.

**Drainage.** The entire state of Tennessee drains directly or indirectly into the Mississippi River and thence into the Gulf of Mexico. The eastern part of the state is drained by the Tennessee River and its tributaries. All streams of the east Tennessee mountains, regardless of their original direction of flow, eventually turn west and flow back into the Tennessee River. The northern part of the state drains through the Cumberland River into the Ohio River. The central section drains into the western leg of the Tennessee River. The Jackson Plain drains directly into the Mississippi through a number of small rivers.

**Climate.** Tennessee has wide variance in climate and seasonal changes between the mountains of the east and the lowlands of the west. Average winter temperatures are relatively low, ranging from a high of 42° F. in the southwest to a low of 34° F. in the east. Zero temperatures occur occasionally in the lowlands, but more frequently in the highlands, where winter temperatures occasionally drop considerably below zero. Summer temperatures are normally warm to hot, with an average for the state of about 76° F. Western and middle sections of the state will average in the eighties during the summer, with occasional rises to 100° F. or above; 70° F. is an average for the mountains of the east. Tennessee's average annual precipitation is approximately 50 in., but the mountains of the east sometimes know as much as 80 to 100 in. in a year. Heaviest rainfall occurs in late winter and early spring. The state average for snowfall is about 9 in., though often there is heavier snowfall in the eastern mountains. Snow rarely remains in Tennessee longer than a few days. The state has an average growing season of from 190 to 200 days.

**Soils.** The soils of Tennessee vary greatly. Their fertility depends largely on the character of the underlying rock and upon slope and drainage conditions. In the eastern mountain region the soil is generally thin, stony, moderately acid, and of low utility. However, in this region, the coves, because of their limestone parent materials, are highly fertile. The soils of the Tennessee Valley in eastern Tennessee are moderately fertile. The Cumberland Plateau and the inner margin of the Highland Rim have, for the most part, thin, porous, unproductive soils and are considered the poorest agricultural areas in the state. The finest soils are found in the Nashville Basin, where the limestone bedrock and its blue-grass covering have produced deep, rich soils high in organic and mineral matter. The Jackson Plain is moderately fertile except in its more rugged portions. On the west, the Mississippi Bottomlands, composed of fine alluvial sands, silts, and clays, are highly fertile and give excellent yields where drainage conditions warrant their use.

EWING GALLOWAY

*The Chimneys, twin mountain peaks in the Great Smoky Mountains National Park*

**Fauna.** The principal animals found in the state are black bear, deer, bobcat, red and gray foxes, raccoon, opossum, skunk, gray squirrel, ground hog, and cottontail rabbit. The wild Russian boar has long been settled in the Cherokee National Forest, and many game birds and animals are frequently restocked. Birds in the state include the mocking bird, bald and golden eagles, northern raven, great blue and green herons, wild turkey, ruffed grouse, quail, robin, bluebird, killdeer, meadow lark, cardinal, towhee screech owl, red-tailed and sparrow hawks, Carolina chickadee, whippoorwill, flicker, woodpecker, and Carolina wren.

Waters throughout the state are well stocked with large- and small-mouth bass, striped bass, catfish, jack salmon, wall-eye, red-horse, spoonbill, crappie, bream, and carp. Though all the large lakes abound in game and other fish, the State Department of Conservation and the T. V. A. stock many streams and small ponds with hatchery fish.

Among the common reptiles of Tennessee are turtles,

frogs, lizards, and thirty kinds of snakes. The rattlesnake, the copperhead, and the cottonmouth moccasin are poisonous. The rattler, known as the diamondback, is found throughout the state, in wooded areas, in rocks near timber, and on the lower balds of the Smokies. Copperheads are usually found in bushy regions, moccasins in or near the water. The swift black snake often grows to a length of seven feet. King snakes, both scarlet and brown, are common to all sections of Tennessee and are deadly to all poisonous snakes.

**Flora.** Tennessee is noted for the abundance of its plant life and for the great variety of its species. In the Great Smoky Mountains alone are found 152 kinds of trees and more than 4,000 different types of plant life. In the Cumberland Mountains 40 types of plant life have been classified that are not known elsewhere in the world. Tennessee's flora form the transition between northern and southern botanical regions. In the mountains of east Tennessee are balsam fir, red and black spruce, sphagnum moss, climbing fumitory, and clintonia, characteristic of the vegetation of southeastern Canada. Rhododendron, iris, big laurel, holly, birch, mountain alder, blueberry, cranberry, and magnolia abound. In the marshy lowlands of west Tennessee are found bald cypress, salt reed grass, water elm, queen's root, hoary verrain, butterweed, cryngo, watershield, swamp white oak, and yellow water crowfoot.

Trees and plants also common to the state are pine, elm, beech, sycamore, basswood, wild cherry, black walnut, hickory, honey and black locust, maple, hackberry, sassafras, persimmon, willow, silverbell, yellow or tulip poplar (the State tree), pecan, tupelo, chinquapin, catalpa, redbud, dogwood, wild grape, pink wildbean, passion flower, trailing arbutus, woodbine, and poison ivy. Golden seal, hepatica, digitalis, and ginsing are among the best known medicinal plants.

About one half of the area of Tennessee—some 13,000,000 acres—is in forest land. In addition to the federally owned Cherokee National forest, there are a number of forests maintained by the state, and much of the area is under private ownership and management. In 1952, 50 of the state's counties were under the state Forestry Division's program of fire protection.

## ECONOMIC RESOURCES AND ACTIVITIES

**Mining and Minerals.** Some 55 minerals of economic importance are found in Tennessee. The bituminous coal fields of the Cumberland Mountains are among the most important. Clays of superior quality are found in limited quantities in the eastern section of the state and in great abundance in the western section. Substantial phosphate deposits occur in the south central section. Much marble is quarried in the eastern part of the state, and the Cumberland Plateau supplies sandstone in commercially important quantities. Zinc and copper are mined. In 1949, Tennessee produced 7,613,560 tons of stone, 4,500,000 tons of coal, 3,964,621 bbl. of cement, 4,056,000 tons of sand and gravel, 1,500,000 long tons of phosphate ore, 1,500,000 tons of zinc ore, and slightly more than 1,000,000 tons of copper ore. Sulphuric acid, a by-product of copper ore, was produced at the rate of 915,956 tons for the year. The total annual income from Tennessee's mineral operations averages $85,000,000.

**Fisheries.** The Tennessee Game and Fish Commission operates hatcheries at Erwin, Morristown, Flintville, and Springfield. They stocked the streams (and some smaller lakes) with large- and small-mouth bass, brook, rainbow, and brown trout, and bluegills. Commercial fishing, confined chiefly to the Mississippi River, Reelfoot Lake, and Tennessee-Kentucky Lake, is of minor importance. The catch consists of carp, catfish, buffalo fish, sunfish, and some crappie; mussel shells are gathered for use in the manufacture of buttons.

**Agriculture.** Farming in Tennessee is now highly diversified and as a result of rural electrification and modern equipment has become more and more productive. Annual cash receipts from crops average $660,000,000 and are growing. The cash value of some of the leading Tennessee crops in 1951 was as follows: cotton, $117,624,000, cotton lint, $103,140,000 and cotton seed, $14,484,000; corn, $105,630,000; tobacco, $66,898,000; hay, $49,708,000; soybeans, $8,485,000; wheat, $6,648,000; oats, $4,969,000; strawberries, $3,852,000; sweet potatoes, $2,871,000; Irish potatoes, $2,001,000; barley, $1,323,000; snap beans, $1,122,000; and lespedeza seed, $1,118,000. There are 1,016,204 persons living on 231,631 farms in the state; farms, buildings, livestock, and equipment in 1951 were valued at $2,300,000,000.

**Animal Industry.** In 1951, livestock was the greatest single source of farm income in Tennessee. The total value of livestock and poultry in the state as of Jan. 1, 1952, was $304,366,000. As of the same date, there were 1,658,000 cattle; 1,330,000 hogs, valued at $31,521,000; 274,000 sheep, valued at $7,343,000; 9,771,000 chickens; 126,000 horses, valued at $4,788,000; and 211,000 mules, valued at $10,550,000. The gross value of dairy products was $105,148,000 in 1951, and Tennessee ranked fifth in the nation in the production of cheese. The production of beef, pork, and mutton was valued at $185,000,000, that of poultry at $40,000,000.

**Horses.** The bluegrass region of middle Tennessee is famous for its horses. Most prominent is the Tennessee Walking Horse, developed from the old plantation horse and having a rolling, easy, "rocking-chair" gait. Thoroughbred, standardbred and American Saddle Bred horses are also raised in this section of the state. Interest in the thoroughbred has recently been revived, following a tradition of the early days of Tennessee, when Belle Meade Farm at Nashville, established in 1835, produced such great horses as Enquirer and Iroquois, the latter the only American horse to win the English Derby and the first thoroughbred to win the sum of $100,000. The Iroquois Memorial, a three-mile amateur race over 18 jumps, is held each May at Percy Warner Park in Nashville and is one of the fastest-run courses in America.

**Lumbering.** At present, Tennessee's rapidly growing forestry program, both state and private, is the basis of an industry with a $250,000,000 annual income. Tennessee is the world's largest producer of hardwood flooring; much of the rest of its lumber goes into furniture manufacture and industrial use.

**Power and Fuel.** Tennessee has an abundance of power and fuel. The T.V.A. supplies some 18 to 20 billion kilowatt hours of electric power annually; the state's coal reserves are estimated at 20,000,000,000 tons, and two natural-gas lines pass through the state and have distribution there.

Better than 85 per cent of Tennessee's farms and rural areas are now electrified, and many thousands of homes throughout the state are heated directly by electricity. Though much of the electric power that might be used by industry has been taken up by such installations as Oak Ridge, many new industries have been installed in Tennessee, particularly in the east, where T.V.A. power predominates. Industrial development of the state's western section is expected with the installation of steam power plants.

FAIRCHILD AERIAL SURVEYS—TENNESSEE CONSERVATION DEPT.

*AIR VIEW OF NASHVILLE, CAPITAL CITY OF TENNESSEE. THE STATE CAPITOL IS SHOWN IN THE INSET.*

**Manufacturing.** Manufacturing is Tennessee's greatest source of income. In 1951, the value added by manufacture was $1,200,000,000; 4,148 plants employed 257,700 persons.

Chemicals and allied products, textiles, and food and allied products are the principal manufacturing industries of the state. Others of prime importance include plastics, leather goods, printing and publishing, stone, clay, and glass products, appliances, and paper and allied products.

The greatest concentration of manufacturing concerns in Tennessee is in the eastern section of the state and around Memphis on the Mississippi River. Since World War II, however, Tennessee has seen the entry of manufacturing plants of various sizes into every section of the state. That section north and east of Knoxville, stretching to the Bristol-Kingsport area, is heavily industrialized. The area around Chattanooga also has many plants. From Memphis, the manufacturing area has spread north and east for as much as 75 or more miles. From Nashville, in middle Tennessee, industry has fanned out both north and south. In this section there are frequently one or two plants to a town, with workers enjoying rural living along with their industrial incomes.

**Banking.** As of June 30, 1952, there were 220 state banks in Tennessee having total assets of $643,017,221 and total deposits of $586,241,172; 74 national banks having total assets of $1,622,035,000 and total deposits of $1,507,405,000; and 3 non-Federal building and loan associations having assets of $2,348,952, private purchasable shares totaling $2,057,230, and deposits of $147,370.

**Tourist Trade.** The third largest industry in Tennessee is the tourist trade, with an estimated dollar volume in 1952 of better than $525,000,000. The state ranks among the top ten in the nation in this category and fourth in the nation in the sale of out-of-state fishing licenses.

The value of taxable property in the state in motels and motor courts alone is more than $80,000,000. More than 10,000,000 tourists visit the state each year.

**Communications.** There are 125 weekly or semiweekly newspapers published in Tennessee. The state also has 62 radio stations, and there are two television stations, one at Memphis and one at Nashville. Installations of telephones throughout the state, particularly in the growing urban centers, was reported in 1952 as up more than 100 per cent over 1946.

**Transportation.** As of June 30, 1952, there were 68,000 miles of roads in Tennessee, of which 15,000 miles were hard surface. The state spends $50,000,000 a year on its roads. Many bus and truck lines serve the state, as do 31 railroads. The principal railroads are the Louisville and Nashville, the Nashville, Chattanooga, and St. Louis, the Southern, the Tennessee Central, the Illinois Central, and the Gulf, Mobile, and Ohio. Railroad mileage in the state totaled 3,540. Tennessee has 55 public airports, of which

LEADING TENNESSEE INDUSTRIES
(1951)

| | *Persons Employed* | *Income from Payrolls and Profits ($1,000)* | *Value Added by Manufacture ($1,000)* |
|---|---|---|---|
| Chemicals | 44,000 | $222,000 | $128,000 |
| Textiles | 37,000 | 108,000 | 116,000 |
| Food products | 26,000 | 104,000 | 243,000 |
| Apparel | 25,000 | 50,000 | 63,000 |
| Lumber (furniture excluded) | 23,000 | 52,000 | 50,000 |
| Primary metals | 14,000 | 142,000 | 206,000 |
| Fabricated metals | 14,000 | 52,000 | 49,000 |

EWING GALLOWAY

*Wilder Tower, in Chickamauga and Chattanooga National Military Park, was erected in memory of Wilder's Federal brigade on the site of Widow Glenn's cabin, headquarters of the Union commander, General W. S. Rosecrans, at the Battle of Chickamauga.*

30 are commercial and 25 municipal; 6 major air lines and 3 feeder air lines serve the state. The Mississippi, Tennessee, and Cumberland rivers provide 1,000 miles of navigable channel.

## GOVERNMENT AND POLITICS

**Structure of Government.** The state legislature, known as the General Assembly, is composed of a Senate and a House of Representatives, consisting respectively of thirty-three members and of ninety-nine members, all of whom serve terms of two years. The Assembly meets biennially on the first Monday in January of every odd year, and the legislators are paid for sessions lasting not more than seventy-five days; for any special session called by the governor they are paid for not more than twenty days. The governor is elected for two years; the secretary of state, the comptroller, and the treasurer are appointed by the legislature for terms of four years. There is a Supreme Court, consisting of five judges elected for eight-year terms, a Court of Appeals, and circuit courts, criminal courts, chancery courts, and inferior courts. In 1952 Frank Clement, Democrat, was elected governor of the state for 1953-1954.

**Legislation and Politics.** Except for abolishing slavery and setting up a judiciary, the present state constitution, drawn up in 1870, is substantially the same as the original document of 1796. Under it, all property must be taxed at the same rate, a provision which bars the adoption of a graduated income tax or the classification of property for taxation. Politically, Tennessee has voted Democratic in presidential elections since the War Between the States except in 1920, 1928, and 1952. In 1953 the state's two senators in Congress were Estes Kefauver and Albert Gore, both Democrats; by the Congressional reapportionment based on the census of 1950, the state's membership in the United States House of Representatives was reduced from ten to nine, effective in the 1952 elections.

**State Finance.** On Jan. 1, 1950, Tennessee ceased to levy a state property tax on real estate, personal property, or mixed real and personal property. Counties, cities, and towns levy a general property tax at varying rates, determined annually in view of their budgets. Railroad and public utilities properties are assessed by the Tennessee Railroad and Public Utilities Commission and are taxed at the rates established by local governments for other kinds of property.

Tennessee levies no graduated individual income tax, but its constitution does authorize a tax levied on income derived from stocks and bonds. The state levies a retail sales tax of 2 per cent and a tax on certain rentals of personal property.

As of July 1, 1944, Tennessee put into effect an amendment to the state payroll tax which is considered a model. Under this amendment, the tax rate for each employer of 8 or more persons who has been taxable for 36 months is made dependent on two considerations: first, upon the employer's experience with unemployment and second, upon the amount in the state's reserve fund for compensating unemployment. This experience-rating plan has saved Tennessee employers $81,000,000 in its first eight years.

General revenue for Tennessee for the fiscal year ending June 30, 1952, totaled $242,000,000. Taxes, licenses, and fees amounted to $180,700,000; Federal aid, $46,600,000; and miscellaneous collection, $10,500,000. Bond sales brought $5,000,000. Of these collections, the sales tax, totaling $50,000,000, and gasoline and motor fuel taxes, totaling $49,600,000, were the largest single sources of revenue. Expenditures for the year totaled just over $245,000,000; $70,800,000 were spent on educational services, and $54,600,000 on highways. The state debt was reduced in the year from $100,200,000 to $97,400,000. The state treasury reported an accumulated surplus of $17,560,267 in the general fund.

## SOCIAL AND CULTURAL ACTIVITIES

**Education.** In Tennessee, education is compulsory for children from the ages of seven to sixteen, or until completion of the eighth grade. In the scholastic year ending June 1951, enrollment in the first twelve grades in the public schools totaled 675,634. There were 4,432 public schools in the state. Segregation is prescribed by law, white and Negro pupils being taught in separate institutions. The average monthly salary for all teachers in public schools, both city and county, was $222.27.

State colleges include the University of Tennessee at Knoxville, Memphis, and Martin; Memphis State College, at Memphis; the Middle Tennessee State College, at Murfreesboro; the East Tennessee Polytechnic Institute, at Cookeville; the Austin Peay State College, at Clarksville; East Tennessee State College, at Johnson City; Tennessee State Agricultural and Industrial University, for Negroes, at Nashville; and the Alvin C. York Agricultural Institute, at Jamestown. Private institutions of higher learning in the state include the University of Chattanooga; Fisk University and Meharry Medical College, for Negroes, at Nashville; Cumberland University, at Lebanon; the University of the South, at Sewanee; Maryville College, at Maryville; Southwestern University, at Memphis; and Scarritt College, Vanderbilt University, George Peabody College for Teachers, and Belmont College, all at Nashville.

Special education is provided for physically handicapped and crippled children; for the deaf and hard-of-hearing; for children of school age who are blind or partially sighted; and for children having defective speech.

**Social Services.** In October 1952, 59,792 recipients of old-age assistance in Tennessee received an average of $36.81 in payments; 59,649 dependent children in 19,693 families received an average family payment of $49.45; and 2,870 recipients of aid to the blind received an average payment of $41.78.

As of Jan. 1, 1952, 9,428 beds were available for mental patients in Tennessee; there were 11,279 beds in general hospitals, 2,441 beds in tuberculosis hospitals, and 3,128 beds in hospitals for chronic diseases.

**Cultural Activities.** There are extensive library facilities in Tennessee, including the Joint Universities Library, supported by Vanderbilt, Peabody, and Scarritt at Nashville. Numerous bookmobiles travel throughout the state. There are several symphony orchestras, notably those at Nashville and Oak Ridge. Several art museums are maintained, offering both permanent and traveling exhibits; the Children's Museum at Nashville is one of the few of this nature in the country, and the Tennessee Historical Society and the Association for the Preservation of Tennessee Antiquities are both active.

## POPULATION

According to the United States Census of 1950, the population of Tennessee was 3,291,718, ranking it sixteenth among the states. This represented an increase of 12.9 per cent over 1940. Figures of the Tennessee State Planning Commission as of September 1952 show that 1,016,204 persons—30.9 per cent—constituted the state's farm population, the remainder living in urban places. Tennessee has a native-born population of 99.49 per cent. Of this, 80.23 per cent is white, 19.26 per cent Negro.

Persons employed in the state in September 1952 totaled 1,093,300. These include approximately 290,000 in agriculture; 276,700 in manufacturing; 180,400 in wholesale and retail trade; 120,100 in state, Federal, and local government; 76,400 in services; 61,700 in transportation and communications; 52,700 in construction; 24,700 in finance, insurance, and real estate; and 10,600 in mining.

## FAMOUS SITES AND PLACES

Tennessee has numerous points of interest, historic, natural, and man-made. The many T.V.A. lakes and United States Engineers lakes offer not only scenes of surpassing beauty, but excellent fishing as well.

Reelfoot Lake, formed by an earthquake in 1811, lies in the northwestern corner of Tennessee; Memphis, the largest city of the state and the largest cotton and hardwood center of the world, has a number of historic points of interest and is the scene of the Annual Cotton Carnival; Shiloh National Military Park, near Savannah, Fort Donelson National Military Park, with the best-preserved breastwork of the War Between the States, and Nathan Bedford Forrest Memorial Park all lie in the western section of the state. In middle Tennessee, the largest blue-grass region in the world, there are a number of natural bridges near Waynesboro; the Meriwether Lewis National Monument; the home of James K. Polk, eleventh president of the United States, at Columbia; Jewell and Dunbar caves; the State Capitol, the Parthenon, Fort Nashborough, the Children's Museum, and The Hermitage, home of Andrew Jackson, all in or near Nashville; the Sam Davis Memorial Home, near Smyrna; and Stones River National Military Park near Murfreesboro.

In the Cumberlands, said to be the world's oldest mountains, are Wonder Cave; historic Monteagle; Rugby, a town established in 1877 by Thomas Hughes, author of *Tom Brown's Schooldays;* and Fall Creek Falls, the highest waterfall in the eastern United States.

Chattanooga has many points of historic and scenic interest. Lookout Mountain, Signal Mountain, and Missionary Ridge all were sites of battles in the War Between the States; Chickamauga and Chattanooga National Military Park is nearby.

Montlake, a geologic phenomenon, is near Daisy; Knoxville is the site of the Blount Mansion, the home of William Blount, and the grave of John Sevier, the first governor of the state. Nickajack Cave and Indian Cave are in east Tennessee. At Oak Ridge there is the American Museum of Atomic Energy.

The Andrew Johnson National Monument and the original tailor shop of the seventeenth president of the United States are at Greeneville. Roan Mountain, high in the Cherokee National Forest, has its annual rhododendron festival, with 600 acres of the beautiful plant in bloom at one time. Erwin is the scene of the annual historical pageant, *Overmountain Men.*

The Great Smoky Mountains National Park and its headquarters town of Gatlinburg draw more visitors each year than any other national park. Tennessee has 17 state parks spread throughout the state, the majority offering vacation facilities, including furnished cottages or hotels. An excellent system of historical markers covers the roads and highways of the state.

Cumberland Gap National Historical Park, on the Tennessee-Virginia-Kentucky border, was scheduled to be dedicated in 1953.

Hunting regulations in Tennessee vary from year to year. There is no closed season on fishing, except for trout. In 1952, out-of-state fishermen could obtain a three-day nonresident fishing permit for $1.00.

## HISTORY

Hernando de Soto, the Spanish explorer who discovered the Mississippi in 1541, presumably stood on present-day Tennessee soil at or near Memphis. No Spanish occupation followed, however, and more than a century later England and France became rival claimants to the region. In 1673 two Virginia traders visited the Indians in the southeastern part of Tennessee, and in the same year Marquette and Joliet landed briefly at the western end of the state. La Salle built Fort Prudhomme at the mouth of the Big Hatchie River in 1682. For the next one hundred years the French and the British, as rivals, attempted to control the Indians and to assert their territorial rights.

In the decade preceding the American Revolution many settlers, stimulated by the glowing tales of hunters and land agents, began to move into Tennessee from Virginia and the Carolinas. They settled along the Watauga, Nolichucky, and Holston rivers in the eastern end of the state and soon set up a completely independent government of their own, which they called the Watauga Association. Several years later the settlers organized the District of Washington, the first local division of government to be named after George Washington. In 1777 the district was annexed to North Carolina, and when that state ceded its western lands to the United States in 1784 the eastern settlers organized the State of Franklin, which maintained a precarious existence for the next four years. North Carolina, having re-established jurisdiction over the area in 1788, and again in 1789, ceded it to the newly established Federal Government. In 1790 the region was organized as the "Territory South of the Ohio River," William Blount becoming its governor. The serious problems of land speculation and settlement, Indian warfare, and Spanish intrigues characterized these formative years.

On June 1, 1796, Tennessee was admitted to the Federal Union as the sixteenth state, with John Sevier as governor. The state was still in the pioneer stage of development. The original state constitution, adopted in 1796, was

revised in 1835 and again in 1870. As a result of a public referendum in 1952, a constitutional convention took place in April 1953 to consider revision of certain specific portions of the constitution. This was the first successful attempt to hold a state constitutional convention since 1870. The capital of the state was finally established at Nashville in 1843; the Great Seal of the state was first used in 1802. During the War of 1812 Tennessee furnished soldiers in excess of its quota and was the scene of much Indian fighting. During the next half century the state showed great progress in canal and road building and in state banking ventures. It was the home of three presidents: Andrew Jackson, James Knox Polk, and Andrew Johnson, and of two presidential candidates: Hugh L. White and John Bell.

Tennessee was the last state to secede from the Union during the War Between the States and the first to return after hostilities ceased. Efforts to bring about secession after the election of Abraham Lincoln were unsuccessful until Fort Sumter was fired on. In June 1861, the people of the state voted to secede by a declaration of independence rather than an actual act of secession. The state was represented in both the United States Congress and the Confederate Congress during the first year of the war, largely because so many east Tennesseans remained loyal to the Union. For the next four years Tennessee was the scene of much bloody and bitter fighting, 454 recorded battles and skirmishes being fought within its borders. The first pitched battle in the West, at Shiloh, Apr. 6-7, 1862, and the last of importance, at Nashville, Dec. 15-16, 1864, took place on Tennessee soil. Forts Henry and Donelson were captured in February 1862, and Nashville was then occupied by Union troops. Andrew Johnson was appointed military governor of the state by Lincoln. Important fighting in Tennessee took place at Murfreesboro, or Stones River, at Knoxville and Chattanooga, at Chickamauga, on the southeastern border, and, in the final western campaign, at Franklin. Tennessee was exempted from the provisions of the Emancipation Proclamation, but abolition of slavery was provided for in a constitutional amendment adopted in February 1865. At that time a Radical state government, headed by William G. Brownlow as Governor, replaced the military government, and on July 24, 1866, Tennessee was readmitted to the Union.

As a result of sectionalism and of Radical control of the governments of the southern states, the Ku Klux Klan was organized in Pulaski in 1866. The organization soon spread throughout the south, and despite its disbandment by its original organizers in 1871, terrorist groups used its name for many years. Radical rule came to an end, and Democratic control of the state was restored in 1870. During the next half century, Tennessee slowly developed its natural resources and industries, though it remained predominantly agricultural for many years. Later, many important textile, chemical, and plastic manufacturing plants became established in the state. One of the largest book manufacturing concerns in the world is located at Kingsport, and coal mining and aluminum production are important industries. Industrial growth and agricultural expansion were extended by the establishment in 1933 of the Tennessee Valley Authority, with headquarters in Knoxville. The T.V.A. won public support as a base of cheap electric power derived from hydroelectric installations in the drainage basin of the Tennessee River. Availability of this power for industry and the attractions of the man-made lakes to tourists were seized upon by Tennesseans, who have developed them in the interests of private enterprise.

At Oak Ridge, north of Knoxville, the first atom bomb was assembled, the laboratories for its manufacture being placed in the area largely because it was both remote and at the same time near transportation and cheap electric power.

State-wide prohibition was enacted in 1909 but was modified by a local-option law permitting package sales beginning in 1939; a workmen's compensation bill became effective in 1919, and the convict-lease law was repealed in 1936. In 1949, the state legislature abolished the poll tax as a prerequisite for voting in primary elections for all state and national offices and exempted women, veterans, and the blind from this requirement in all elections. Permanent registration for the state's voters was established in 1951. Sgt. Alvin C. York, of Pall Mall, Fentress Co., and the Hickory Division became world-famous in World War I, during which Tennessee contributed nearly 100,000 men to the armed forces. During World War II the state contributed 241,000 men and 2,442 women to the army, and 44,047 men and 1,073 women to the navy. T. R. H. and T.S.

**TENNESSEE, UNIVERSITY OF,** an accredited, coeducational, state-controlled institution. The main campus is at Knoxville, Tenn., but the colleges of Medicine and Dentistry, the Graduate School of Biological Sciences, the schools of Pharmacy and Nursing, and the Division of Public Health are all located at Memphis. The University of Tennessee Junior College is located at Martin, and substations of the Agricultural Experiment Station are located at Jackson, Columbia, Clarksville, Crossville, Greeneville, and Springfield. Tennessee University occupies a total area approximating 4,500 acres. It was originally established in 1745 as Blount College. In 1807 it became East Tennessee College, and in 1840 it became East Tennessee University. The school was incorporated as the Agricultural and Mechanical College in 1869, and ten years later it became the University of Tennessee.

The divisions of the university include agriculture, liberal arts, home economics, engineering, education, law, business administration, graduate school, medicine, dentistry, pharmacy, nursing, public health, and biological sciences. These divisions offer the following degrees: the A.B.; the B.S. in chemistry, business administration, education, home economics, pharmacy, agriculture, and chemical, civil, electrical, mechanical, agricultural, and physical engineering; the LL.B.; the M.D.; the D.D.S.; the M.S.; the M.A.; and the Ph.D. A branch of the Graduate School has recently been opened at Oak Ridge as part of the Nuclear Studies Institute.

Chapters of many fraternities and sororities have been established on the campus and male students are permitted to live in the fraternity houses. Dormitories and dining facilities have been provided for both men and women. Scholarship assistance is generous and a loan fund has been established. *For statistics see* COLLEGES AND UNIVERSITIES.

J. R. To.

**TENNESSEE AGRICULTURAL AND INDUSTRIAL STATE UNIVERSITY,** an accredited, coeducational, state-controlled institution for Negroes. It is primarily an institution for teacher training and is a land-grant college which occupies 470 acres in Nashville, Tenn. The school was originally established in 1909 by the Tennessee general assembly and at that time was called the Agricultural and Industrial State Normal School. In 1922 the privilege of granting degrees was received, and during the following year the present name was adopted. In 1951 the institution was reorganized into the four schools of Engineering, Arts and Sciences, Education, and Graduate Studies

The degrees offered include the A.B. in liberal arts, the B.S. in business administration and engineering, the M.S., and the M.A.

Chapters of several sororities and fraternities have been established on the campus. Dormitory facilities are available but most of the students commute. Scholarship assistance is limited. *For statistics see* COLLEGES AND UNIVERSITIES.

J. R. To.

**TENNESSEE POLYTECHNIC INSTITUTE,** an accredited, coeducational, state-controlled, technological institution. It occupies a 221-acre campus in Cookeville, Tenn. The school was originally chartered as a junior college in 1915, but in 1928 it was reorganized as a senior college and received the power to grant degrees. The degrees offered are the B.S. in liberal arts, business administration, engineering curricula, agriculture, and home economics. Dormitories are available for both men and women, but most of the students commute. There are no national sororities or fraternities on the campus. There are no scholarships offered and only a small fund is available for student loans. *For statistics see* COLLEGE AND UNIVERSITIES. J. R. To.

**TENNESSEE RIVER,** 652 mi. long, the largest tributary of the Ohio River. The headwater streams of the Tennessee River are the French Broad and Holston rivers, which join 4 mi. north of Knoxville, eastern Tennessee, to form the Tennessee River. The river flows generally southward through the Great Appalachian Valley to Chattanooga, where it turns north from Lookout Mountain to Walden Ridge. It then flows southwest into northern Alabama, where it bends to the northeast at Guntersville Dam and again flows into Tennessee. The river then bends to the north as it crosses western Tennessee and southwestern Kentucky to enter the Ohio River at Paducah, Ky. The Tennessee River is noted for being unusually free from sediment and having a steady flow of water. The Muscle Shoals Navigation Power Dam, part of the Tennessee Valley Authority, is located on the river near Florence, Ala. The major tributaries are the Duck, Clinch, Hiwassee, Sequatchie, Big Sandy, and Little Tennessee rivers, and Bear Creek; the whole system drains an area of about 40,569 sq. mi. The Tennessee is important as a source of the power which has developed and influenced the whole Southern economy. The most important cities on or near the Tennessee River are Paducah, Ky.; Savannah, Chattanooga, and Knoxville, Tenn.; and Florence and Decatur, Ala. J. E. F.

**TENNESSEE STATE COLLEGE, EAST,** an accredited, coeducational, state-controlled institution, primarily for teacher training. The school occupies a 162-acre campus in Johnson City, Tenn. It was originally established in 1909 as the East Tennessee State Normal School. The power to grant degrees was received in 1925 and the name was changed to East Tennessee State Teachers College. The present name was adopted in 1943. The B.S. is the only degree awarded. Dormitories and dining halls have been established for both men and women. There are no national fraternities or sororities on the campus. No scholarships are offered, but a substantial fund has been established for loans to students. *For statistics see* COLLEGES AND UNIVERSITIES.

J. R. To.

**TENNESSEE STATE COLLEGE, MIDDLE,** an accredited, coeducational, state-controlled institution for the training of teachers. The college occupies about 375 acres in Murfreesboro, Tenn. The school was originally established in 1909 as a normal college and students were first admitted two years later. In 1925 the power to grant degrees was received and the name was changed to State Teachers College. The present name was adopted in 1943. The only degree offered is the B.S. in education, with some majors in business and liberal arts. Dormitories and dining halls are provided for both men and women, and living quarters are made available to married veterans. There are no national fraternities or sororities on the campus, and, as no provision has been made for scholarship and student loans, many of the students earn all or part of their expenses. *For statistics see* COLLEGES AND UNIVERSITIES. J. R. To.

**TENNESSEE VALLEY AUTHORITY.** In the first years of the twentieth century private enterprise had become interested in the possibilities for hydroelectric power development at Muscle Shoals on the Tennessee River in northern Alabama. No action was then taken, but alert members of Congress were awakened to the possibilities of combining power development with river navigation improvements, all under public control.

Participation of the United States in World War I caused President Woodrow Wilson to approve the building of a nitrate plant at the site, and construction was started at the present sites of the Wilson Dam and the Wheeler Dam, both at Muscle Shoals on the Tennessee River in northern Alabama. Before the plants were completed the war ended, and the Government planned to lease the nitrate plants to private enterprise. Various proposals were received, but Congressional delay, and the introduction of bills providing for the establishment of a government corporation to control and operate the Muscle Shoals properties, postponed any final action. In the meantime the Wilson Dam and powerhouse had been completed and the electric power generated was sold on various contracts from 1925 to 1934 to the Alabama Power Company.

In his first inaugural address, President Roosevelt, recognizing that conditions existing in the river's watershed presented an opportunity for economic and social experimentation, asked for legislation to end "the continued idleness" of the Muscle Shoals development and "to enlist this project in the service of the people." He proposed legislation "to create a Tennessee Valley Authority—a corporation clothed with the power of Government, but possessed of the flexibility and initiative of a private enterprise." On May 18, 1933, the President approved an act of Congress establishing the Tennessee Valley Authority (T.V.A.). The revenues to be derived from the sale of the hydroelectric power, a by-product of flood control and conservation, were expected, eventually, to make the T.V.A. self-sustaining from an economic viewpoint, while at the same time raising the level of social welfare and economy in the area. Flood control, the production of cheap electricity for power and lighting purposes, the manufacture of large quantities of fertilizer for agricultural purposes, the institution of soil conservation programs and of better farming methods, as well as other benefits, have resulted. The first board chosen to carry out the program had Arthur E. Morgan, a distinguished engineer who was then president of Antioch College at Yellow Springs, Ohio, as chairman, with Harcourt A. Morgan (no relation), president of the University of Tennessee, and David E. Lilienthal of the Wisconsin Public Service Commission as the other two directors, appointed respectively for nine, six and three years.

The T.V.A. had hardly got under way before it was subjected to court action on the grounds of unconstitutional government interference with private competing interests.

Constitutionality of the T.V.A. act, though only in an indirect form, was finally established by the United States Supreme Court in *Tennessee Electric Power Company* v. *Tennessee Valley Authority* in 1939. This case was the culmination of prolonged litigation challenging the legality of contracts entered into by T.V.A. with municipalities. Furthermore, while the constitutional question was being debated in the courts, a controversy raged among the directing personnel on questions of administration. The controversy was resolved when the President removed Arthur E. Morgan from office and later made Lilienthal chairman.

In the midst of the controversy within the board of directors of the T.V.A., the opposition from privately owned public utilities in the area reached a climax. The Commonwealth & Southern Corporation, headed by Wendell Willkie, had, for six years, been engaged in an effort to prevent public ownership of electric utilities in the T.V.A. area. Private investors were reluctant to invest in the securities of corporations that might be taken over by T.V.A. through court action at condemnation proceedings. To make his claim more effective and to publicize his problem, Willkie went to the White House and presented such a clear statement of his case that what could be considered a fair price was paid for the Commonwealth & Southern property.

In connection with this controversy, one of the Government proposals was that T.V.A. rates for electricity be used as a "yardstick" for measuring the fairness of utility rates in contiguous T.V.A. territory and, in fact, throughout the country as a whole. This proposal was rejected by the privately owned utilities, which contended that such comparisons were unfair. T.V.A. paid no taxes, it was able to secure funds, as required, at lower interest rates than could be obtained by private utilities. Operating deficits were made up from public taxes in the form of deficiency appropriations. T.V.A., it was charged, had other advantages, not the least of which was the fact that it was a government corporation. In addition, it was contended that conditions were not the same in all parts of the country. None of these objections, however, prevented the T.V.A., after the United States Supreme Court had indirectly given its approval in 1939, from proceeding to carry out its authorized program in the Tennessee Valley.

Another potential handicap that T.V.A. has had to surmount or evade was that of political interference both with its operation and with its personnel. The United States Senators from Tennessee were insistent that the appointment of employees of the Authority be turned over to Congress so that the Senators could designate and control the appointments. Numerous amendments to this effect were attached to important bills in Congress, but they were defeated. Congress, however, did make a concession to the recalcitrant senators by withdrawing the blank check appropriation method and substituting requirements for detailed accounting of expenditures. The T.V.A. has been criticized for failing to pay its own way. Its profits have been characterized as illusory and misleading. In spite of subsidies, the T.V.A. has paid only a token interest on its investment and none into a sinking fund. The American tax-payer has paid most of the interest. But the claim is made by its proponents that the T.V.A. should not be considered from the sole viewpoint of earning power, but rather from that of over-all benefit to the locality, the state, and the nation; that the T.V.A. created values where none had previously existed; and that it has enhanced the value and worth of the territory in which it operates, either directly on the land or through the sale and re-sale of large quantities of cheap electricity which brought businesses into the region and thus gave employment where no such opportunity had previously existed.

Again, because its functions represented a new relationship between government, the local community, and private industry, the T.V.A. aroused both local and national praise and opposition. Its critics characterized the project as an experiment in socialization and regimentation, in which the local citizens and industries would be ruled and directed by a government corporation financed by tax-payers' money. Advocates and supporters of the undertaking insisted that unorganized and aimless use of the natural resources of the region had destroyed much of their value and that no organized efforts were being made to conserve, restore or replace these resources; that no attention was given to the social welfare of the people of the region; that planning, when done at all, was haphazard, unrelated and inadequate; and that available natural resources, especially power in various forms to be derived from the harnessing of the waters of the Tennessee Valley, would provide the funds and the means of overcoming the handicaps imposed on the region by haphazard methods and exploitation.

To a varying degree the T.V.A. has accomplished the purposes for which it was created. It has constructed a system of flood control that has been effective; it has produced and sold electricity in such quantities as nearly to finance the costs of the various projects; it has immensely improved the social, economic and living conditions in the area; it has greatly increased the use of inland waterways in the area; it has introduced reforestation and soil conservation measures that have increased the productivity of the region; it has produced a quantity and variety of fertilizers that have been of great value in increasing land productivity wherever they have been used; and during World War II the T.V.A. proved to be an asset of great value because of its ability to provide large volumes of electric power for national defense, particularly in connection with the atomic energy program carried on at Oak Ridge. All of these benefits have not been confined to the T.V.A. area. Many of the products produced in the territory have gone elsewhere. The practical problems worked out have served as models for other parts of the country, and the increased population and purchasing power have provided profitable markets for goods produced outside the area.

T. R. H.

**TENNIEL, SIR JOHN** [tɛ'nyəl] (1820-1914), English painter and illustrator, was born Feb. 28, 1820, in London. He was a student at the schools of the Royal Academy, where his later work was exhibited. In 1850 he joined the staff of the humorous magazine, *Punch,* to which he contributed a weekly political cartoon. As a painter, he carried out a commission for a fresco in the Parliament buildings, depicting St. Cecily (1846). He was also a member of the Royal Institute of Painters in Water Colours, and his water colors have found places in many museums. Tenniel is well known as the illustrator of Aesop's *Fables* (1848) and Lewis Carroll's *Alice's Adventures in Wonderland* (1865) and *Through the Looking Glass* (1872). He died in London, Feb. 25, 1914.

C. P. P.

**TENNIS.** The game of tennis, or lawn tennis as it is more properly called, is of comparatively modern development. Its history dates from December 1873, when Major Walter Clopton Wingfield introduced the sport to his guests at a garden party on his estate at Nantclwyd, Wales. It was his adaptation of the ancient game of kings, court tennis, which has a history of seven hundred years. In 1874 Major

Wingfield, an officer in the British Army, patented the game under the Greek name of Sphairistike. The court on which it was played was in the shape of an hourglass, measuring 60 ft. long, 30 ft. wide at the base lines, and 21 ft. wide at the center, where a net was suspended. The net was 7 ft. high at the ends and sagged to 4 ft. 8 in. at the middle. Sphairistike was introduced into the United States in the spring of 1874 by Miss Mary Ewing Outerbridge, whose brother, A. Emilius Outerbridge, received permission for her to set up her net and mark out the hourglass-shaped court on the grounds of the Staten Island Cricket and Baseball Club at St. George, Staten Island. Newport and Philadelphia became early centers of tennis, along with New York and Boston. The first important tournament was at Staten Island in 1880.

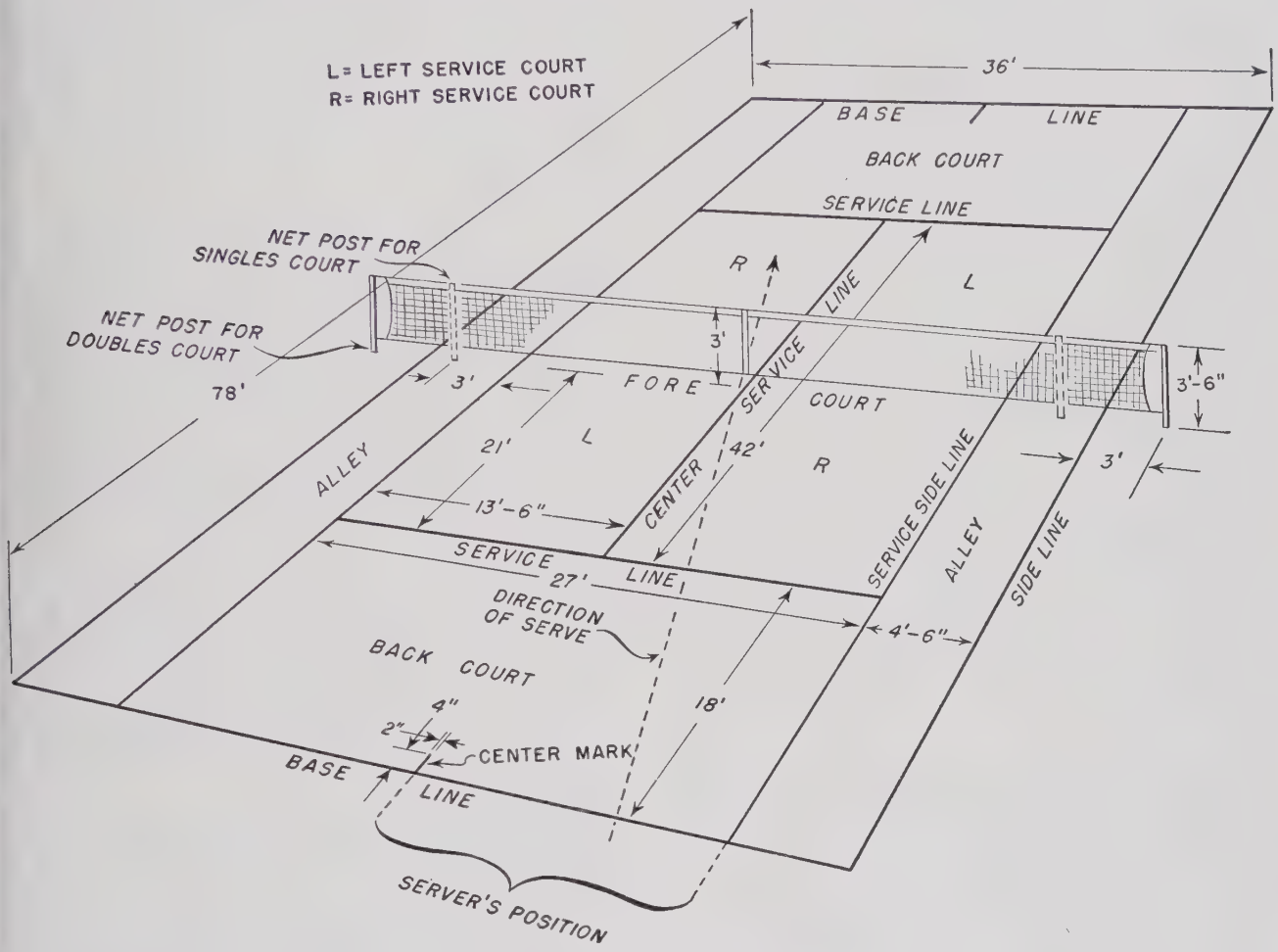



DIAGRAM OF A TENNIS COURT

## LAWN TENNIS

Confusion and controversies over varying sizes of balls, differences in the height of the net, and the playing rules led to a demand for standardization of the rules, regulations, and playing equipment. A meeting was held in New York on May 21, 1881, at which the United States National Lawn Tennis Association was organized. The national championship was started at that time.

**Court and Equipment.** Tennis is played on a rectangular court of varying surfaces. The surface most used in the United States is clay. Other surfaces are grass, cement, asphalt, patented compositions, concrete, and wood. The fastest outdoor surface is grass, and it is on grass that the most important championships are held in the United States, England, and Australia. In the countries of Europe, fast-drying, composition surfaces are the rule.

The court measures 78 ft. in length and 27 ft. in width for singles. For doubles, in which there are two players on each side, the width is 36 ft. Most courts are laid out for doubles, with inner boundaries marked for singles. The court is divided into two equal parts by the net which is suspended from a cord or metal cable, each end of which passes over the top of a post, 3 ft. 6 in. in height and standing 3 ft. outside the court on each side. The height of the net at the center is 3 ft. The boundary lines of the court are known as base lines and side lines. On each side of the net, 21 ft. from it and parallel with it, is drawn the service line, extending from side line to side line. The center service line, 2 in. wide, divides the space from the net to the service line on both sides of the court into service courts. Each base line is bisected at the center by a line 2 in. wide and extending 4 in. into the court, known as the center mark.

The ball is a hollow rubber sphere, inflated to a high pressure, with an outer surface of tightly drawn flannel. It must measure between $2\frac{1}{2}$ in. and $2\frac{5}{8}$ in. in diameter, and weigh between 2 oz. and $2\frac{1}{16}$ oz. There is no official restriction on racket size or material, but most rackets are made of laminated wood, are strung with gut or nylon, weigh less than 1 lb., and are about 27 in. long and 9 in. wide.

**Method of Play.** The game of singles is played with one player to a side, doubles with two. Service alternates with each game, and courts are exchanged after every odd-numbered game in each set. The first service in a game is delivered from any point behind the baseline between the center mark and the right sideline; thereafter, the service alternates from right to left of the center mark with each point of the game. The ball is always delivered to the service court diagonally opposite on the far side of the net. The server tosses the ball into the air and hits it with the racket before the ball hits the ground. In doing this he must not walk or run, must maintain contact with the ground, and must keep both feet behind the baseline, until the racket strikes the ball. Failure to observe these requirements results in a "foot fault," and the service is judged not good. To be a fair service, assuming no foot fault is called, the ball must touch within the boundaries of the proper service court without touching the net. If it tips the net before landing fairly, a "let" is called, and the service is repeated. If the ball does not land in the proper service court, a "fault" is called and the service is judged not good. If the first service is a fault, a second service is allowed. A let is not counted as a service. Two service faults in succession are called "double fault" and count as a point for the receiving player.

The receiver usually stations himself near the baseline, about halfway between the center mark and the sideline. He may not play the service until it strikes in his service court. He then attempts to return it to any part of the opposite court. In turn, the server attempts to return the ball, and a "rally" ensues, ending when one player commits an "error" or scores a "placement." An error is made when the ball is driven into the net or beyond the boundary lines; a placement is made when the ball is so directed that the opposing player is unable to reach it and make a return. Except on the service, a ball tipping the net before landing in the proper court is good; except on the service, the ball may be hit before it bounces and must on all occasions be hit before it bounces twice.

*Scoring.* A player making a service ace (a service that the receiver is unable to return successfully) or a placement, or whose opponent commits a double fault or an error, wins the point. The first point for each player in a game is called "fifteen," the second "thirty," the third "forty," and the fourth "game." No points is "love." A forty-forty score is called "deuce," and it is then necessary for one player to win two successive points before game is reached. The point won after deuce is called "advantage"; it is "advantage in" if the server is ahead, "advantage out" if the receiver leads. If the player gaining advantage loses the next point, the score reverts to deuce. The player first winning six games wins a "set," except that when each has five games, one must then win two games in succession to take the set. Matches are decided by the best of three sets, or the best of five.

*Doubles.* Doubles play is similar to singles. The two members of each team move about the court as they please (except the server in the act of serving); they are not required to hit the ball alternately, as in some other racket games. They take turns serving, each serving a complete game every other time it is the team's turn to serve. Scoring is the same as in singles.

**Championships and Players.** Richard D. Sears won the first seven United States singles championships, a record run never since equalled. William A. Larned later won seven titles, five in succession, and after World War I William T. Tilden II, said to be the greatest player of all time, also won seven titles, six in succession. Maurice E. McLoughlin helped to popularize tennis before World War I with his extremely fast "cannonball" service. William Johnston won the singles title twice and reached the finals six other times. After Tilden, only Ellsworth Vines, Donald Budge, and Jack Kramer rose to comparative dominance over American tennis.

The earliest successful foreign players in American tennis were Reginald and Hugh Doherty of Great Britain in the early 1900's. Norman Brookes and Anthony Wilding of Australia played fine tennis in the United States before World War I. In the late 1920's France's Rene Lacoste, Henri Cochet, Jean Borotra, and Jacques Brugnon ruled American and world tennis. In the early 1930's Fred Perry of Great Britain and Jack Crawford of Australia were outstanding; later Baron Gottfried von Cramm of Germany and John Bromwich of Australia made strong showings. Frank Sedgman and other Australian stars dominated tennis in the early 1950's.

*Women.* May Sutton, who won both American and British championships, was the first great American woman tennis player. She was followed by Hazel V. Hotchkiss and Mary K. Browne. Molla Bjurstedt won eight singles titles during and following World War I. Helen Wills, ranked with Suzanne Lenglen of France as the greatest of all women tennis players, won seven American and eight British singles titles. From 1932 until World War II, Helen Jacobs, Alice Marble, and Sarah Palfrey dominated American singles and doubles championships. Pauline Betz, Louise Brough, and Margaret Osborne were outstanding in the 1940's, the latter two winning the national doubles title nine years in succession. Maureen Connolly rose to rule women's tennis in the early 1950's.

*International.* Various countries compete annually for the Davis Cup, a trophy put up in 1900 by an American, Dwight F. Davis. Although many countries have entered Davis Cup play, only four have ever won the cup; the United States, Australia, Great Britain, and France. British and American women's teams have played annually since 1923, except during World War II, for the Wightman Cup, donated by Mrs. George W. Wightman, the former Hazel V. Hotchkiss.

*Professional.* Professional tennis began in earnest in 1926 when Suzanne Lenglen, Mary K. Browne, Vincent Richards, and others went on an exhibition tour. William T. Tilden turned professional in 1930, to be followed later in the 1930's by Ellsworth Vines, Fred Perry, Don Budge, and others. Robert L. Riggs, former singles champion, tried to revivify professional tennis after World War II, but although he persuaded Jack Kramer and other great stars, both men and women, to join him, professional tennis did not meet with conspicuous success.

## COURT TENNIS

Court tennis, the game from which lawn tennis is derived, is over seven hundred years old and at one time was played by the monarchs of continental Europe and England. Highly popular with the masses from the fourteenth to the nineteenth century, by the middle of the twentieth century it had a very small following, limited to membership in a few exclusive clubs in England, France, and the United States. Its introduction into the United States occurred in 1876, when a private court was built in Boston.

**The Court.** Court tennis is played in an indoor court measuring 110 ft. by 38 ft., with a skylight 30 ft. overhead. The four walls and the floor are made of cement. Some of the modern courts, with their dressing rooms, baths, showers, and other appurtenances, have cost as much as $250,000.

Among the features of the court are a roofed shed, running around three sides of the court, and the tambour. The shed is called the penthouse. The tambour is a projection of one of the long walls on the hazard side. The other side of the court is known as the service side.

**Method of Play.** As in lawn tennis, a racket and a flannel-covered ball are used. A net divides the court at the middle, and the scoring is similar to that of lawn tennis. But there are important variations. The play is not only over the net but also against the walls. There are numerous openings in the walls, and when the ball is directed into the dedans (gallery at service end of court), grille, and winning gallery, a point counting fifteen is scored. Certain wall openings mark "chases," and there are chase lines on the floor. The chase is a stroke whereby the ball, untouched by the receiving player, enters any but the winning gallery or falls anywhere but on or beyond the service line of the hazard side; the purpose is to give the opponent a chance to make a better shot before he loses the point.

The serving is done entirely on the service side, and the ball, on service, must strike on the roof of the penthouse. Points are scored by making a placement on the floor, by a service ace, and by hitting into the winning wall openings. Points are lost by hitting the ball into the net or out of court above the play line high on the walls, or by failure to reach the ball and return it. The player winning six games, sometimes eight, takes the set; and matches are decided by the best of three sets or the best of five in championship play.

Jay Gould, amateur champion from 1906 until he retired in 1926, and the only amateur in history to win the world title, and Tom Pettitt, professional who won the world championship, were the two greatest players developed in the United States. Pierre Etchebaster, a French Basque living in the United States, was the world champion in 1928 and for a quarter century thereafter.

### PADDLE TENNIS

Frank Peer Beal, a fourteen-year-old boy in Albion, Mich., who lacked the space to build a lawn tennis court in his backyard, conceived the idea of a paddle tennis court in 1898. In 1921, then associate minister of the Judson Memorial Church in Washington Square, New York, he laid out courts on the floor of the church gymnasium. With the cooperation of the department of parks, the game was later introduced into public parks, playgrounds, and supervised play streets. The American Paddle Tennis Association was organized in 1923, becoming the United States Paddle Tennis Association three years later. Today the game is played outdoors and indoors throughout the country.

**Method of Play.** Paddle tennis has practically the same strokes, rules, scoring, and strategy as lawn tennis but can be played in a much smaller space. The dimensions of the senior court, slightly larger than the junior, are 44 ft. by 16 ft., the doubles court being 20 ft. in width. The net is 2 ft., 6 in. high at the center and 2 ft. 9 in. at the posts outside the side lines. Four service courts are marked out as in lawn tennis, extending 12 ft. from the net. Only one serve is permitted in senior play and two in junior. The paddle, or bat, is made of laminated plywood. There is a perforated, metal-bound, oval-shaped paddle, 16¾ in. long, 8⅛ in. wide, and weighing 13 to 14 oz., but the cheapest and most commonly used is a rectangular bat measuring 14¾ by 7¾ in. It must not exceed 17 in. for senior play. The ball is approximately 2½ in. in diameter, which is about the same size as the lawn tennis ball, but it is made of light sponge rubber and is not so lively.

**Platform Paddle Tennis.** This all-year outdoor game was invented in 1928 by Fessenden S. Blanchard and James K. Cogswell of Scarsdale, N.Y. In 1932 the first open tournament was held, a year after the Fox Meadow Tennis Club of Scarsdale became the first club to put in courts. In 1934 the platform group organized as the American Paddle Tennis Association. The game spread throughout the country, particularly in sections where freezing temperatures and snow prevented winter-time activity in lawn tennis. The game is played on a permanent platform erected on a special foundation, and also on a portable platform which can be placed on top of a lawn tennis court. The dimensions of the platform court are the same as in paddle tennis. The platform itself is 60 by 30 ft. Backstops and sidestops measuring 12 ft. high enclose the court. Rules, scoring, and strokes of the platform game are the same as in the regular paddle tennis game, but because of the fact that the backstops are "in play" the strategy is quite different. Also, platform tennis is almost exclusively a doubles game.

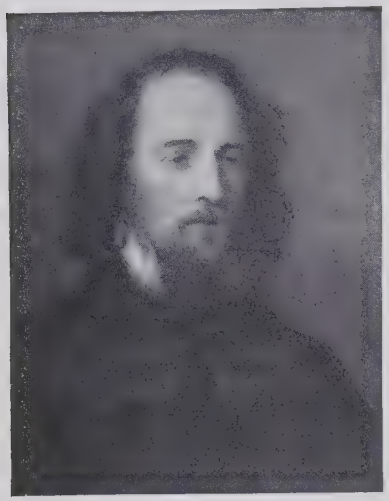
A. D.

**TENNYSON, ALFRED** [tɛ′nɪsən] (1809-1892), English poet, was born Aug. 6, 1809, at Somersby, Lincolnshire, the fourth of twelve children. Raised to the peerage in 1884 as Baron of Aldworth and Farringford, the title designating his residences in Surrey and the Isle of Wight, he is commonly styled Lord Tennyson. Poetry was his all-embracing interest from early youth until death, an interest strengthened, apparently, by family influence, the cordial appreciation of his early work by trusted friends, and his own success in winning the Chancellor's Medal at Cambridge in 1830.

The poetry of Tennyson may be divided roughly into three periods—one in which his interest was mainly lyrical, a second in which it was mainly narrative, and a third in which it was mainly dramatic. This division is approximate, however, since outstanding exceptions occur in each period. Tennyson's lyric period culminated with the publication of *In Memoriam,* in 1850, the year of his appointment as Poet Laureate and of his marriage to Emily Sellwood, to whom he first became engaged in 1837. Until 1842 it was a period of obscurity, marked by the hostility of critics and by the personal sorrow and perplexity that family problems and the death of his beloved friend A. H. Hallam brought upon Tennyson; it was made more oppressive by the sensitivity of his temperament, which belied his massive, athletic physique. In 1827 Tennyson and his brothers Frederick and Charles published a volume of poetry anonymously, which they entitled *Poems by Two Brothers,* although it contained contributions from all three. *Poems, Chiefly Lyrical,* containing *The Poet,* which set forth Tennyson's poetic creed, and *Mariana,* appeared in 1830 and was followed, at the end of 1832, by another volume, *Poems,* notable for *The Lotos Eaters* and *The Lady of Shalott.* Hurt by the rough critical treatment that the second volume received, and deeply shocked by the death of Hallam in 1833, Tennyson preserved silence for the next ten years, except for occasional contributions to the then popular "annuals." He broke this silence with *Poems* (1842), containing *Locksley Hall, Ulysses,* and *Morte D'Arthur,* which brought him general acclaim. In 1845 Tennyson received a pension from the English government, and in 1847, *The Princess* added to his fame.

The narrative period in Tennyson's work, which extends from 1850 to 1875, embraces the publication of *Maud and Other Poems* (1855), a collection in which the perennially popular *The Brook* first appeared, *Enoch Arden* (1864), and the greater part of *Idylls of the King* (first four idylls published in 1859). The third period began in the 1870's,

when Tennyson became absorbed in poetic drama and produced his first play, *Queen Mary,* in 1875. It was followed by six more, all of them except *Harold* being staged with more or less success, but they are now little known and have moved into the realm of closet drama. Tennyson devoted substantial time and thought to them, especially to *Queen Mary, Becket,* and *Harold,* which he envisaged as a trilogy portraying the making of England.



*ALFRED TENNYSON*

FROM AN ENGRAVING BY J. STEPHENSON OF A PAINTING BY G. F. WATTS

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The poet's old age was one of astonishing vitality and productiveness, manifested in the publication of five volumes between 1880 and 1892. The last part of *Idylls of the King* appeared in 1885 and *Crossing the Bar* in 1889. Tennyson died Oct. 6, 1892, at Aldworth, and was buried with ceremonial honors in Westminster Abbey.

By virtue of his irreproachable personal and domestic life, his eloquent and frequent expressions of noble ideals, his felicitous descriptions and interpretations of nature, his abounding patriotism, and his sense of responsibility to the public, he represented, especially after his appointment as laureate, an ideal of the poet widely held in England and the United States in the nineteenth century. His relations with Queen Victoria and the royal family were almost those of an intimate friend, and with the public generally he was enormously popular. Becoming a legend in his own time, he was sought out by tourists from abroad, particularly from the United States, much as if he were the object of a holy pilgrimage. To later critics this situation has seemed unfortunate because it suggests that Tennyson allowed himself to be molded too much by the taste of his era. He thus did not, perhaps, realize completely his pre-eminent ability as a lyricist and as a master of metrics, and his intuitive perception of the awe-inspiring mysteries and sublimities of life and the universe was not fully expressed. He enjoyed a reputation as a thinker and seer which is not borne out by his writings, but there is a measure of justice in the opinion held by some scientists of his age that he was the one poet to understand science. *See also* ENOCH ARDEN; IDYLLS OF THE KING; IN MEMORIAM; MAUD; PRINCESS, THE. R. B. D.

**TENOR,** a term in music for (1) the highest male voice produced naturally; (2) the second lowest part in four-part writing; (3) members of the trombone, saxophone, and other instrumental families corresponding roughly to the tenor voice in range; and (4) that voice in early polyphonic music which carried the *cantus firmus* or "theme," against which the other voices sang contrapuntal variants. W. Li.

**TENREC** [tɛ'nrɛk], a large insectivore of the family Centetidae, restricted solely to Madagascar. The tenrec resembles the hedgehog in outward appearance, though lacking the spines of the latter. The animals are sparsely covered with coarse hairs; in some species the dorsal hairs form stout bristles. Tenrecs are prolific animals, occasionally bearing 15 or 16 young at a birth; a female carrying 25 embryos has been recorded. During the dry season the tenrec remains in its burrow, passing several months in a semitorpid condition which may be likened to hibernation. The tenrec's food consists of a variety of small insects and grubs. W. J. Ha.

**TENSE AND ASPECT.** The verb in the modern Western languages is divided into tenses which have as their main (although by no means unique) function to indicate time. Every English, French, or Italian verbal form is in the present, past, or future tense. In English, the most rational of European languages, tense has reached an apex of logical consistency; apart from the type *I have seen* (which is a variety of the present), English has but one present (*I see*), one past (*I saw*), and one future (*I shall see*). The element of time is so important in the verb that as early as the fourth century B.C. Aristotle declared that it was the verb's characteristic feature—a statement that was much less true for the Greek of his time than it would be for Modern English. German grammarians, when they had to create a grammatical term for the verb, called it *Zeitwort.* In fact, there is no other part of speech in which time is expressed by structural modifications.

Tense, however, is a relatively late development in the history of language, for consideration of time is a characteristic of an adult, mature, and intellectualistic mind. Primitives, like children, know little about time, and care less. Primitive Indo-European seems to have had no tenses in our modern sense, that is, no temporal expression whatever. Verbal inflection in Indo-European drew distinctions on another, quite different basis, *aspect,* i.e., manner of the action, or the way in which the action expressed by the verb takes place.

There were and there are still in some languages many types of aspect: ingressive, effective, terminative, unique, intensive, iterative, and others; the two most important ones are, however, the imperfective, indicating that the action has not reached it goal, is not accomplished, and the perfective, indicating that it does reach its goal. Among the modern Indo-European languages, the Slavic tongues have best preserved this system: almost every Slavic verb has at least these two aspects, and sometimes more. What is in English a lexicological distinction—*to talk: to say; to look: to see; to listen: to hear; to beat: to kill; to walk: to go*—is in Slavic a morphological distinction of primary importance; in each of these pairs of verbs the first may be taken to be the imperfective aspect of the second, the perfective. A man can talk a long time and say nothing; he can walk days and days and go nowhere. Likewise, *call, cry, shout, shriek,* and *scream* can each be considered a different aspect of the same verbal action. English has still other means of expressing different aspects, such as *he starts eating* (ingressive), *go to sleep* (ingressive), *he stops crying* (effective), *they hunted him down* (perfective; but in *they hunted all day long, hunted* is imperfective); and similarly, *dry out, rinse out, lie down, stand up, burn up.* Periphrases with such words as *grow, turn, wax, get, cease, stop, continue,* and *keep* are also used. In Slavic the perfective aspect, i.e., the concrete, particular, precise way in which a general, indeterminate action or trend finds its end, is frequently expressed by a

preposition prefixed to the imperfective stem. In English the type is *they hunted him down, he tore it away, they broke it up, look up, wipe off;* it is frequent in Latin, and also in German (e.g., *jagen: erjagen; schreiten: überschreiten; reisen: verreisen*).

Clear traces of this aspectual, tenseless era can still be clearly seen in Greek, Latin, and the modern Western languages. The opposition between aorist and present in Classical Greek, outside of the indicative mood (where time was indicated by the augment ε-), was aspectual, not temporal (e.g., the imperatives γράφε and γράψον; the subjunctives γράφω and γράψω). Likewise the whole Latin verbal system is based on the opposition of two stems—called by some linguists *infectum* and *perfectum*—which represent two different aspects, each of them with a present (or preterito-present), a future, and a past: *fac-io, fac-iam, fac-iebam; fec-i* (cf. *od-i, nov-i*), *fec-ero, fec-eram*. This aspectual opposition is still quite clear in the Latin of Republican times, and weakens only later. Sometimes, as frequently in Slavic, two or even more different stems are coupled together to express an opposition of the same sort: in Latin, for example, in *sum, ero, eram: fui, fuero, fueram;* in Greek, in ὁράω, εἶδον, ὄψομαι; and even in English (transformed into tenses), in *I am, we are, I was, I be,* and *I go, I went*. The originally timeless character of the English preterit can still be seen in such preterito-presents as *he can, he may, he will, he shall* (cf. *he saw, he gave, he ate;* also Latin *odi, novi, memini;* German *er mag, er kann, er soll, er will, er darf*). The recent character of the future tense in English can still be observed in its clumsy and inadequate expression of future time, illustrated in the well-known disastrous cry of the drowning man: *I will drown and nobody shall save me!* The heavy German future with *werden* (not very much used even now) is also recent; Proto-Germanic and even Gothic had no future tense.

English has, in addition to other forms, the so-called "expanded" form of the verb, also called "progressive," which is built periphrastically with the gerund and the verb *to be*: *he is eating, he is working*. This form usually expresses duration, though not in the sense that the action expressed by it lasts longer than the simple form. Sometimes it lasts much less long, as in the sentence *Augustus reigned forty-five years: while he was reigning, the Roman legions suffered a disastrous defeat.* But the form expresses duration in the sense that the mind of the reader lingers on the action, describes it, and develops it, whereas the simple form merely sums it up abstractly as a unique whole: *he died the evening of the 30th of December; he was dying the evening of the 30th of December*. The expanded form corresponds therefore to a certain extent to the Slavic imperfective aspect and to the French and Italian imperfect tense, while the simple form (especially in the past) corresponds to the Slavic perfective aspect and the French and Italian *passé défini, passato remoto: he ate, il mangea, mangiò; he was eating, il mangeait, mangiava*. The simple form frequently indicates that the action is accomplished (*Peter went to Washington* means that he really arrived there); the expanded form, that the action is not accomplished (*he was going to Washington* may mean that he never reached the city). The element of duration is almost always inherent in the imperfective aspect, the element of nonduration or instantaneity in the perfective (*he got up*). When one or the other of these elements predominates, we speak, respectively, of linear or punctual aspect. The element of time can here be seen penetrating into the aspect, but in the sense of duration, not in the chronologically defined senses of present, past, and future.

English possesses also, according to some scholars, an intensive aspect in the periphrastic construction with *do* (outside of the interrogative and negative clauses, where it is usual and therefore not expressive): *Do you see the ship? I do see it. Do go, please.*

Aspect is an extremely delicate grammatical category, one that is exceedingly difficult to define. It presents innumerable strange and contradictory facts, and has been the object of endless and often useless discussion. It can be truly said that aspect is as manifold as human sensations and images, and that every verb has, in a sense, its own aspect. G. B.

**TENSOR** [tɛ′nsər], in mathematics, a quantity having components in each of a given set of co-ordinate systems, the components in any one system being related to those in any other system by a prescribed law. Tensors include vectors and scalars as special cases. They are defined in geometrical spaces of any number of dimensions and play an important role in differential geometry, relativity, and certain branches of mathematical physics.

As an example, consider the vector in $n$-dimensional space whose components in the $x$-co-ordinate system are $\xi^i$ ($i = 1 \ldots n$) and whose co-ordinates in the $x'$-co-ordinate system are $\xi'^i$. Let $x'^i = f^i(x' \ldots x^n)$ relate the two co-ordinate systems. If the respective components are related by the law

$$\xi^i = \sum_{j=1}^{n} \frac{\delta x^i}{\delta x'^j} \xi'^j \quad ,$$

then the vector is called a contravariant vector. Similarly, if the relation is

$$\xi_i = \sum_{j=1}^{n} \frac{\delta x'^j}{\delta x^i} \xi'_j \quad ,$$

the vector is called covariant.

A general tensor has the form $T^{i \ldots j}_{a \ldots b}$. Its law of transformation is:

$$T^{i \ldots j}_{a \ldots b} = \sum T'^{r \ldots s}_{c \ldots d} \frac{\delta x^i}{\delta x'^r} \cdots \frac{\delta x^j}{\delta x'^s} \frac{\delta x'^c}{\delta x^a} \cdots \frac{\delta x'^d}{\delta x^a}.$$

It is said to be contravariant in the indices $i \ldots j$, and covariant in the indices $a \ldots b$.

Two geometrical examples of tensors are as follows: (1) the coefficients of the first and second fundamental forms of a curved surface; these are covariant tensors with two lower subscripts; i.e., they are covariant of the second order. (2) the coefficients of any quadratic algebraic form, such as

$$a_{11}x^2 + 2a_{12}\,xy + a_{22}y^2,$$

relative to linear co-ordinate transformations.

Two physical examples of tensors are as follows: (1) the inertial tensor whose components are the moments and products of inertia of a rigid body; (2) the stress tensor whose components describe the stresses exerted upon an elastic body by external forces. This latter application contributes the name tensor to this concept. *See also* DIFFERENTIAL GEOMETRY; VECTOR ANALYSIS. C. B. A.

**TENT CATERPILLAR,** the common name given to the larvae of certain moths of the family Lasiocampidae, which build tents in which they spend the day, coming out toward evening to feed. The common tent caterpillar, *Malacosoma americana,* and the Great Basin tent caterpillar, *M. fragilis,* are the two best-known tent builders. The eggs are

laid in a mass surrounding the twig of the food plant. As soon as they hatch, the young larvae build a silken nest, which is enlarged as they grow; when they leave the nest to feed, each spins a silken thread which it follows on the return trip. The forest tent caterpillar builds no nest; both the adults and the larvae resemble the tent-building caterpillars in general appearance, and caterpillars of the two groups may feed together on the same tree. The chief food of the tent-makers is wild cherry, but they also feed on other fruit trees. Wild cherries, when defoliated, bring forth a new crop of leaves, but in orchards tent caterpillars may cause serious damage. The forest tent caterpillar feeds on a wide variety of deciduous trees. Arsenical sprays destroy the larvae; in another method of control, the tents may be burned with a torch to destroy the young larvae. C. H. Cu.

LILO HESS

*TENT CATERPILLARS*

**TENURE, LAND.** *See* LAND TENURE.

**TEOTIHUACÁN.** *See* TOLTEC.

**TEPHILLIN** [təfɪ′lɪn] (Eng. phylacteries), two small leather boxes containing pieces of parchment upon which passages from the Torah (Exod. xiii:1-10, 11-16; Deut. vi:4-9; xi:13-21) are written. Tephillin are worn by Jewish men above the age of thirteen and have leather straps attached to them, by which they are tied to the forehead and the left arm. In ancient times they were worn on all occasions, but later only at daily morning prayers; they are not worn at all on Sabbaths and festivals. The etymology of the word *tephillin* is uncertain, but possibly the word is connected with the Hebrew word *tephilah* ("prayer"). The use of the tephillin is based on the Biblical injunction "And thou shalt bind them [the preceding words] for a sign upon thine hand, and they shall be as frontlets between thine eyes" (Deut. vi:8). Reform Jews interpret this passage figuratively and do not wear the tephillin.

Together with the tephillin, the *tallith,* a prayer shawl, is worn; but unlike the tephillin, the tallith is worn also at the morning services of Sabbaths and festivals. The tallith is a fringed mantle, made of silk or wool. It varies in size, large ones being big enough to envelop the wearer. The significant feature of the tallith is the long fringes (Heb. *zizith*) at the four corners, which fulfill the commandment "bid them that they make fringes in the borders of their garments" (Num. xv:37). Orthodox and Conservative Jews also wear a fringed undergarment known as *tallith ḳatan* ("small tallith").

While it is possible that in very early times both the tephillin and the fringes had talismanic or magical significance, there is no such suggestion in the Bible or in other Jewish literature. The purpose of both is mnemonic; they are meant to remind the wearer of God's presence and of His word. D. G. and G. W.

**TEPLICE** [tɛ′plɪtsɛ] (Ger. Teplitz-Schönau), formerly Teplice-Sanov, a noted resort center and industrial city in northwestern Czechoslovakia. It is on the southern slopes of the Ore Mountains, 12 mi. west of Ustí nad Labem and about 50 mi. northwest of Prague, in the heart of the Bohemian lignite mining area. The local industries of the town, largely German since medieval times, brought in Czech laborers during the late nineteenth century under Austro-Hungarian rule. In 1925 large numbers of Czechs came into the area at the instigation of Czech authorities, who had controlled it since 1918. A strong German center, it was within the Sudetenland that went to Germany after the Munich agreement in 1938 and was returned to Czechoslovakia in 1945. A beautiful medieval castle and its gardens are noteworthy sites, and hot springs, known since A.D. 762, make Teplice one of the most popular resorts in Czechoslovakia. There are rail and highway connections to Ustí nad Labem, Most, and Prague. In Teplice and its neighboring villages considerable lignite is produced, in addition to glassware, metal goods, textiles, and food products. The German population was sent back to Germany during 1946 and 1947 and was replaced by Czechs. Pop. 1947, 45,183. F. Sc.

**TEQUENDAMA FALLS** [te′kendɑ′mɑ], a waterfall 16 mi. southwest of Bogotá, Colombia, formed as the Río Bogotá drops over a 475-ft. precipice in a mass of spray. It is one of the most beautiful falls in the Americas. In Chibcha legend, the god Bochica created it to drain away flood waters. A smaller cataract above the falls provides electricity for Bogotá. P. E. J.

**TERAH** [ti′rə], in the Old Testament, the father of Abraham, Nahor, and Haran (Gen. xi:26). He emigrated from his native city, Ur of the Chaldees, to the city of Haran in Syria, and died there at the age of 205. Jewish tradition, based on Joshua xxiv:2, makes of Terah not only an idol worshiper but a maker of idols, and this estranged him from his son Abraham, who was a firm believer in the Lord. M. A. G.

**TERAMO** [tɛ′rɑmo], a province and also the capital city of that province, in an agricultural area in the region of Abruzzi e Molise in east central Italy, on the Adriatic slope of the Apennines.

**The City.** Teramo lies midway between the Monte della Laga and the Adriatic Sea, at an elevation of 900 ft. above the level of the latter and about 40 mi. northwest of Chieti. Teramo rests on a tongue of high land formed by the junction of the Tordino and Vezzola rivers. The older and lower part of the city has the narrow and crooked streets of a medieval town, while the new and upper portions are more spacious and open. The climate is characterized by mild winters and hot summers; the annual rainfall averages 34 in. The city is essentially a market place and administrative center for the circumjacent agricultural zone and is connected with the main Adriatic railway line by a branch connecting at Giulianova. The Romanesque cathedral, started in the twelfth century and restored in the fourteenth, and its cam-

panile, as well as one of two medieval churches, constitute the outstanding monuments of the city. Roman remains, including a theatre of Hadrian's epoch, have been unearthed. Built on the site of ancient Interamna (Interamnia, Teramne), the medieval and modern city of Teramo has undergone the succession of rulers, chiefly foreign, common to the Abruzzi. The city was undamaged in World War II. Pop. (off. est. 1947) 38,190.

**The Province.** The province of Teramo, comprising 45 communes, has an area of 752 sq. mi. It extends from the Adriatic Sea to the heights of the Apennines (Gran Sasso); on the south it is bordered by the province of Pescara and on the north by the Marches. Approximately 45 per cent of the province is classified as mountainous; most of the remainder is hilly, since the coastal plain is quite narrow. Wheat and grape culture predominate, but some olives, vegetables and other fruits are also grown. Cattle, sheep, and swine are raised. Nearly three-quarters of the working population is engaged in agriculture; industry is hardly represented at all. There are no towns of any size in the province except Teramo. Pop. (est. 1947) 270,000. R. G. W.

**TERBIUM.** *See* RARE EARTHS.

**TERBORCH, GERARD** [tərbɔ′rχ] (1617-1681), Dutch genre and portrait painter, was born in Zwolle, Holland, in 1617. He studied first under his father, and from 1632 to 1635 under Pieter de Molijn in Haarlem. He traveled to England in 1635, to Italy in 1641, and to Amsterdam about 1645. He was in Münster from 1646 to 1648, where he portrayed the ratification of the Treaty of Westphalia by Philip IV, and then he went to Spain, where he was knighted by Philip. He returned to Zwolle in 1650 for a few years' stay, and finally settled in Deventer.

Excelling in small-scale portraiture, Terborch revealed the personality of his subjects with dignity and intimacy. His most characteristic works are single-figure or small-group genre scenes of fashionable ladies engaged in reading or writing letters, playing the lute, or indulging in similar pastimes. In soldier-scene paintings he developed early the silver-gray flesh halftones and the shimmering reflected highlights which keynote his style. Color was applied sparingly and glazed by degrees to produce the rich, molten effect that defines the play of light and shadow over tapestries, furs, and satins. Terborch died in Deventer Dec. 8, 1681. R. A. K.

**TEREDO** or **SHIPWORM** [təri′do], the popular name for members of the family Teredinidae of bivalve mollusks, which live in sea water and often damage wooden ships, docks, and other submerged wooden structures. Most shipworms have elongated wormlike bodies that sometimes reach a length of several feet. The sexes are separate. Fertilized eggs are released by the parent after they reach a certain stage of development. The embryos are carried by the currents, and if they come in contact with wooden structures they immediately try to burrow into the material by spasmodic openings and closings of the shell valves. In four or five hours an embryo can be hidden from view. Soon after the embryo buries itself in the wood it changes its shape and begins to grow, rapidly excavating long burrows. If the infestation is severe, a piece of wood may be virtually honey-combed by the burrows, which are made by a rasping motion of the shells. The burrows are lined with a calcareous coating. *Teredo thompsoni* and *T. chlorotica,* small-sized shipworms, are common from Maine to Florida. Those of the related genus *Bankia,* especially *B. setacea,* which is common from Alaska to San Francisco, are the largest North American shipworms, reaching a length of 4 ft. V. L. L.

**TEREK** [tyre′rık], a leading river located in the pre-Caucasus in the southwestern Soviet Union. With a length of 371 mi., it rises on the north slope of Mt. Kazbek as the Res Don, at an elevation of over 11,500 ft., and flows east and then north as a mountain stream through the Daryal Pass (7,940 ft.) forming the route of the Georgian Military Highway through the forested mountains to Ordzhonikidze (formerly Vladikavkaz). Below this city it enters the lowlands and turns abruptly east and later northeast to its delta on the Caspian Sea. The river drains an area of 23,053 sq. mi. Its only right-bank tributary is the Zunsha. Left-bank tributaries include the Ardon, Uruk, and Macka. Principal cities along its banks are Ordzhonikidze and Mozdok. The river is navigable 254 mi. above its mouth to its junction with the Macka, and floods are frequent in its lower course. C. C. H.

**TERENCE (PUBLIUS TERENTIUS AFER)** [tɛ′rəns] (c. 195-159 B.C.), Roman comic dramatist, was born in Carthage, brought to Rome as a slave, and there freed. He became an intimate friend of Scipio, in whose circle were statesmen and men of letters interested in improving and refining Latin. Terrence's six comedies, *fabulae palliatae* like those of Plautus and likewise adapted from the Greek New Comedy, were produced in 166-160 B.C. The *Andria* (*The Lady of Andros*), *Heauton Timorumenos* (*The Self-Tormentor*), *Eunuchus* (*The Eunuch*), and *Adelphoe* (*The Brothers*) were based upon originals by Menander; the *Phormio* and *Hecyra* (*The Mother-in-law*) upon originals by Apollodorus. In 160 B.C. Terence made a journey to Greece, where he died the following year.

Terence's comedies have a spirit very different from that of the Plautine dramas. They contain little song and dance, and lack the broad humor and farcical treatment to be found in the work of the older playwright; the language is less vigorous and racy than that of Plautus and jests and puns are rare. Terence's humor is not derived from exaggerated characterizations and laughable situations, but is the same "thoughtful laughter" which George Meredith considered typical of Menander and Molière. Although lacking the range and variety of Plautus, Terence's treatment of plot and character is far more subtle. There is less trickery and more use of mistaken identity and recognition, a practice in which Terence was following the example of Menander. The slaves, unlike the intriguing and insolent servants in Plautus, are sometimes deceived or kept in ignorance of the truth. The fathers are more dignified and reasonable, and their confusions and misunderstandings develop naturally from the situation, as in the *Phormio, Hecyra,* and *Adelphoe.* The courtesans are often portrayed as generous and noble, as are Thais in the *Eunuchus* and Bacchis in the *Hecyra,* and even more unconventional is Terence's delineation of Sostrata, the patient and self-sacrificing mother-in-law in the *Hecyra.* An outstanding feature of Terence's dramatic technique is the dual plot, in which the two love affairs of the two young men, often brothers or cousins, are interwoven; the happy solution of the one love affair is dependent upon that of the other. All of Terence's comedies except the *Hecyra* have this dual plot.

One of Terence's most striking innovations was his use of the prologue. Plautus in his prologues had given the background of the plot and had often made a humorous appeal for the audience's favor; Terence, on the other hand, elimi-

nated from the prologues all reference to the plot and made them chiefly a defense against the unfavorable criticism of other dramatists, especially that of a playwright named Lucius Lanuvinus. He referred to his practice of adding a part from a second Greek original and defended this procedure, known as *contaminatio,* by the example of his predecessors, Naevius, Plautus, and Ennius. Partly by his omission of the plot from the prologue and partly by his handling of the action, Terence, as in the *Phormio* and the *Hecyra,* often kept the spectator in the dark concerning the secrets of the plot and made him experience the same confusion and uncertainty as the characters; in this way he was able to create more suspense than had Plautus and the Greek playwrights.

The art of Terence was far more Greek than Roman; his plays lacked the Italian qualities of Plautus and contained no allusions to Roman localities or events. Terence wished to reproduce as faithfully as possible the thought and expression of the Greek originals. He was a dramatist with a high ideal of artistic perfection, and he did much to bring elegance and restraint to the Latin language. Caesar praised him as "a lover of faultless speech" (*"puri sermonis amator"*), and his maxims (*sententiae*) lent themselves to frequent quotation by later writers: "Fortune favors the brave," "A word to the wise is sufficient," "So many men, so many minds," "The quarrel of lovers is the renewal of love," "Where there's life, there's hope." Like Plautus, Terence had a great influence on Renaissance dramatists; Molière made adaptations of the *Phormio* and the *Adelphoe,* and the influence of his plays upon English playwrights of the seventeenth and eighteenth centuries was partly direct and partly indirect through Molière. G. E. D.

**TERESA DE JESÚS, SANTA** [tere′sə the hesu′s] (1515-1582), Spanish mystic and saint, was born in the Castilian town of Avila, Mar. 28, 1515. She was christened Teresa de Cepeda y Ahumada. In her later works, many of them autobiographical, she relates her avid childhood reading of lives of the saints, and such romances of chivalry as *Amadís de Gaula,* a book which inspired the imagination of almost every Spaniard of the time. Her mother died when Teresa was twelve, and this loss, along with her subsequent education at an Augustinian school, and, in particular, her reading of St. Jerome, confirmed her spiritual vocation. In 1534, accordingly, she entered the Carmelite convent in Avila, where she submitted her sickly disposition to the required ascetic exercises with such zeal that her health was impaired, and she suffered an illness which was to recur throughout her life. Her first experiments in contemplation led to a long period of indecision and hesitancy, a period which ended, she writes, only after her reading of St. Augustine. In 1556 a period of intense mysticism began, and she experienced a number of divine visions, one of which, a vision of Hell, led her to undertake the reform of her order. In 1562 the first convent of reformed or discalced (barefoot) Carmelites was opened, and Teresa's continued efforts on behalf of the movement brought such a storm of opposition from followers of the older rule and their supporters that in 1578 she was denounced to the Inquisition and confined in Toledo. Her disciple, John of the Cross, who undertook a similar reform among the male Carmelites, was made to suffer an even more harsh imprisonment at the same time. During the long, active period of the foundations of her movement, Teresa's progress along the paths of mysticism continued, and it is her integral combination of the practical and mundane with a spiritual vocation that marks her greatness. The reform of the Carmelites achieved complete triumph in 1580, when Philip II intervened and caused the reformed branch to be established as a separate monastic province. Teresa died at Alba, Oct. 4, 1582, and was canonized in 1622.

The autobiographical works of Santa Teresa can be understood only when it is realized that they were not written for publication, but rather at the request of her various confessors and spiritual mentors. Of these, the *Libro de su vida* ("Book of Her Life") was written in 1566 and published at Salamanca in 1588 after her death. The *Libro de las fundaciones* ("Book of the Foundations"), which she began in 1573, was not published until 1613. Santa Teresa's more than four hundred letters reveal even more intimately the texture of her personality: realistic diplomacy, humor, and an intimate poetic imagination emerge without conflict from an inner realm of complete spirituality. Santa Teresa's works of mysticism, her doctrinal expositions, are at once exalted and familiar, but never technical. Particular mention should be made of two books: *Las Moradas* ("The Dwelling Places"), written in 1577 and published in 1588, an allegory of mystical progress which describes the seven-chambered "interior castle" of the soul; and the *Camino de perfección* ("Path of Perfection"), published in 1583, which advises nuns in the practice of contemplation. These books, like those of autobiography, were written for an intimate circle of disciples and friends and were not intended for wide circulation. They were composed with tremendous speed and were organized with an intuitive rather than a rhetorical or formal logic. The homely metaphors, provincialisms, and sudden insights of Santa Teresa's style present the entire being of the woman in action. Her works have in this way a special human clarity unknown to many writers of doctrine. Their importance is not only ecclesiastical but literary, and today they are ranked by readers of all faiths as among the prose masterpieces of the Spanish language. *See also* CRUZ, SAN JUAN DE LA. S. G.

**TERESINA** [terəzi′nə], an industrial city and the capital of the state of Piauí, in northeastern Brazil, situated on the Parnaíba River, about 270 mi. south of the port city of Parnaíba. The city has direct air and river transportation facilities, and rail service from Senador Furtado across the river to the port of Sao Luis. The local industrial output reflects the region's produce, with sugar and cotton products among the most important items. Pop. 1950, 51,418. S. G. I.

**TERMAN, LEWIS MADISON** [tɜ′rmən] (1877- ), American psychologist, was born in Johnson Co., Ind., Jan. 15, 1877, and was educated at Indiana University (A.M. 1903) and Clark University (Ph.D. 1905). After teaching in public school and normal school, he went in 1910 to Stanford University where he was professor of psychology from 1916 until his retirement in 1942, and head of the department for twenty years. He received honorary doctorates from Indiana University (1929), the University of California (1945), and the University of Pennsylvania (1946) and was president of the American Psychological Association in 1923. He is widely known for his two "Stanford" revisions of the Binet mental tests (1916, 1937), for their use in selecting superior children whose personality and later careers he studied, and for other ability and personality tests he devised and applied. He was author or co-author of *The Measurement of Intelligence* (1916), *The Intelligence of School Children* (1919), *Mental and Physical Traits of 1000 Gifted Children* (1924), *The Early Mental Traits of 300 Geniuses* (1926), *The Promise of Youth* (1930), *Sex and Personality* (1936),

*Measuring Intelligence* (1937), *Psychological Factors in Marital Happiness* (1938), and *The Gifted Child Grows Up* (1947). F. A. K.

**TERMINUS** [tɜ′rmɪnəs], a Roman god of boundaries and property limits represented by a stone or post set in the ground with appropriate ceremonies. Sacrifices were annually offered at these boundary stones, at the festival of the Terminalia, on February 23. Originally Terminus was probably an epithet of Jupiter, and his statue, or sacred boundary stone, stood at Rome in the temple of Capitoline Jupiter. G. E. D.

**TERMITE,** the name given to any member of the insect order Isoptera. Another common name is "white ant," but termites are not ants and are readily distinguished from them: in termites the abdomen is joined to the thorax in almost its full width and the wings have numerous veins; in ants, the abdomen is joined to the thorax by a slender waist and the wing veins are few in number.

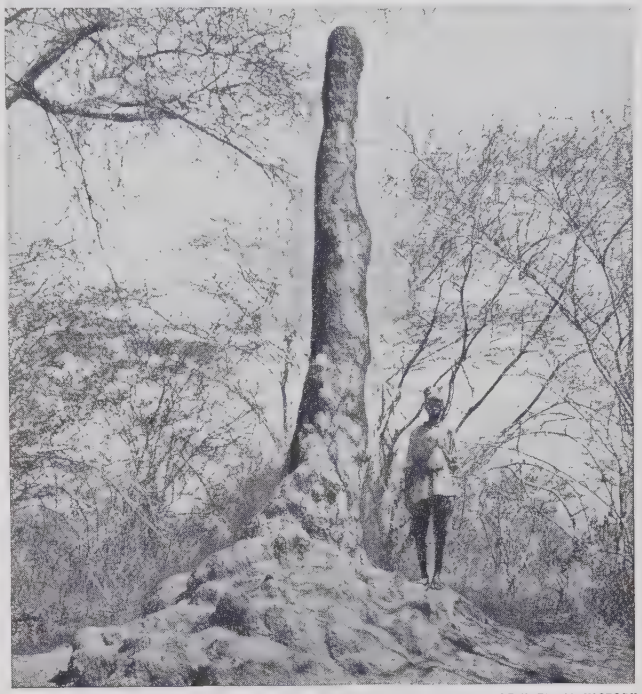
**Colonial Organization.** Termites are social insects, and their colonies may consist of a few dozen to many hundreds of thousands of individuals. In the simplest colony there may be found only a queen, a king, and many workers, but most colonies contain at least two types of workers, one with the head greatly enlarged; this type both works and fights. In the more complicated colonies there are many different classes of individuals: the king and the queen, the fertile male and female which originally established the colony; the supplemental reproductives, which are also fertile but are smaller than the king and queen and may be either short-winged or wingless; and, making up the rest of the colony, the workers and soldiers, both of which are sexually undeveloped females, pale-colored and wingless. The soldiers are larger than the workers and may occur in two types: those with large mandibles and those with the front of the head prolonged into a snout.

Although all the reproductives lay eggs, the queen usually lays the greatest number, in some species a total of as many as 30,000 a day. The winged sexual forms usually develop once a year; they are brownish in color, have a hard integument, and are able to stand bright sunlight. After mating, or in some species before, they search for a suitable place in which to establish a new colony, and they then dispose of their wings, which, weak at the base, are easily broken off.

**Termitaria.** All termites build nests either underground or above ground. The dry-wood termites feed on dead wood, and their nest is a maze of tunnels within the material on which they are feeding. The forms that feed on the roots of grasses and other plants build large cemented-earth termitaria that may project several feet above the ground; those six-feet high are common in tropical areas, and there are many records of termitaria reaching a height of twenty-five feet. On the plains of Africa and Australia such termitaria are a menace on aircraft landing fields, and considerable difficulty has been experienced in eliminating them. The shape and structure of these termitaria vary with the different species.

**Food.** Termites feed for the most part on cellulose, which they cannot digest completely. Protozoans, which live symbiotically in the hind gut of the termite, digest the cellulose partially; the termite then digests the remainder. Since they live in a protein-poor environment, termites have been forced into a very strict protein economy, in which the old and decrepit members of the colony are consumed and even their own excrement is eaten.

**Biology.** Termites are essentially tropical insects, but a few kinds have spread to the temperate regions. In the United States the native termite is *Reticulitermes flavipes.* It is a subterranean species that builds its nest in the ground and normally feeds upon dead trees and branches, or dead areas in living trees, but it also feeds on the wood in buildings and sometimes causes serious damage. In the southern United States there are several species of dry-wood termites that nest



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*Termites' nest in the Suk country, Kenya, East Africa*

in the wood itself; in the tropics there are dry-wood termites that build their nests in or upon dead areas of trees. If termites are unable to travel from their nests to the source of their food supply without coming into bright light, they build tunnels of wood and earth through which they can travel in safety. If these tunnels are broken, the soldiers protect the workers while the tunnel is being repaired.

**Value of Termites.** Although some kinds are injurious to man's home and crops, termites are for the most part beneficial, since they destroy dead wood which might otherwise remain on the forest floor for many years. Many kinds are eaten as a staple food diet in Africa and other tropical regions: in the Congo the natives have their own termitaria from which they annually collect the sexual forms as they emerge for their nuptial flights. The queens, which may exceed an inch in length, are highly prized as food in many parts of the world; they are usually eaten raw. C. H. Cu.

**TERN,** any one of a large aggregation of species of medium-sized to small (9 to 24 in.) web-footed sea birds of the subfamily Sterninae of the family Laridae. They are mainly birds of the warmer coasts of the world, but a number of them range in season as far as the arctic and antarctic regions. They differ from their nearest relatives, the gulls, in their more slender bodies, their tapering, pointed bills, their longer, narrower wings, and their relatively shorter legs and smaller feet. Most species, especially the pelagic ones, have long, deeply forked tails. Their plumage forms combinations of black, white, and gray; it may have, in the

breeding period, a lovely roseate tinge on the breast. Terns are famous for their graceful flight, and they are often called "sea swallows." They seldom rest upon the water, but hover in the air until some small aquatic animal is sighted and then plunge upon it. They breed in colonies, depositing

L. A. FUERTES—U. S. FISH AND WILDLIFE SERVICE

*BLACK TERN*

their disproportionately large eggs in an unlined hollow on the beach, or, in the case of the fresh-water species, in a nest made of floating marsh vegetation. H. G. De.

**TERNATE** [tɛrnɑ′te], a small, heavily forested island, about 25 sq. mi. in area, lying off the central west coast of Halmahera Island, in Indonesia, at 1° N. lat. and 127° 30′ E. long. Ternate, one of the Moluccas, is a volcanic island with peaks rising to 5,600 ft. The chief town, also named Ternate (pop. 7,126), is located on the east coast. Settled by the Portuguese in 1521, it is an important port of call, long noted for its trade in spices. Other exports are rattan, teakwood, copra, and bird skins. Pop. (est. 1940), 20,000. R. G. B.

**TERNI** [tɛ′rni], a province and the capital city of that province, situated in the region of Umbria, in central Italy.

**The City.** The ancient city of Terni, which has become one of Italy's principal industrial centers, is located on the Nera River, a few miles below its confluence with the Velino. It is surrounded on three sides by the foothills of the Apennines, about 45 mi. northeast of Rome. Until 1879, when the metallurgical industry was established in the city, Terni was a small village. The chief industrial establishments of the metropolitan area produce munitions and war matériel, railway equipment, iron and steel products, chemicals, textiles, sugar, and rubber goods. The power for these industries is supplied by the hydroelectric power generated at the falls of the Velino and other near-by rivers. Because of its strategic industrial importance, Terni during World War II was subjected to over 120 Allied air raids, which destroyed more than half of the central part of the city. Known in Classical times as Interamna Nehars, the city was the home of the historian Tacitus. After the fall of Rome it was devastated by the Goths in A.D. 546, by the Byzantines under Narses in 553, and by the Lombards in 755. It continued to be a point of dispute among near-by states, including Spoleto and Narni, until 1420, when it came under the control of the Roman Catholic Church. In 1860 Terni was annexed to the Kingdom of Sardinia, which a year later became the Kingdom of Italy. Pop. (off. est. 1947), 82,183 (including suburbs).

*Cascate delle Mármore, famous cataract in the Velino River near Terni, Italy*

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**The Province.** Created in 1927, Terni Province comprises thirty two communes and embraces an area of 826 sq. mi. It lies entirely within the middle basin of the Tiber River, and its terrain is hilly, with low mountains of about 4,000 ft. in height near its capital. In spite of the concentration of industry in the capital area, agriculture is the chief activity of the province. About half the productive land is sown to crops such as cereals, sugar beets, and other vegetables, while one third is devoted to woodlands and one eighth to pasture land. The province is well supplied with rail and road communications. Pop. (off. est. 1947), 211,000. R. G. W.

**TERNSTROEMIA** [tɜrnstri′miə], a genus of warm-temperate and tropical evergreen shrubs, native to Asia, the Indian Archipelago, and America, and belonging to the tea family, *T. japonica,* native to Japan and India, and planted for its handsome bronzy foliage, grows in the southern United States, and is hardy as far north as San Francisco. It grows to about 20 ft. tall and is more treelike than shrubby. L. de F.

**TERPANDER** [tɜrpa′ndər], Greek poet and musician, was born at Antissa on the island of Lesbos. History has not preserved a large body of incontestably accurate information about Terpander, but scholars generally agree that he played an important part in the development of Classical music and lyric poetry in Greece during the first half of the seventh century B.C. A performer on the lyre and the flute, Terpander composed for both instruments. He is said by some to have been the first to have increased the number of strings on the lyre from four to seven, but others credit him only with the introduction into Greece of an improved lyre invented elsewhere. Terpander's poetry was for the most part in hexameters, but he made many metrical innovations, for some of which he was fined by the Ephori. He is credited with the development of the nome, a sacred poem sung in honor of a god to the accompaniment of the lyre and the flute. Terpander won first prize in the musical contests at the Carnean Games in 676 B.C., and, according to Plutarch, he won first prizes in the contests held in connection with the early Pythic Games. Some authorities attribute to Terpander the invention of musical notation and the beginnings of the science of musical notation, but this is widely contested. Terpander is often described as the father of Greek lyric poetry and Classical music. H. Bol.

**TERRA COTTA** [tɛ′rə kɒ′tə], literally Italian for "cooked earth." Clay baked for hardness and resistance to water may be called "terra cotta," although the term is sometimes restricted to the architectural and sculptural uses

of the material. It may be glazed for luster, color, figured decoration, and complete waterproofing, and it is then called "glazed terra cotta." The unglazed form is distinguished by the term "biscuit." Terra cotta was widely used in the ancient world, both Eastern and Western, as well as in pre-Columbian America. It was sufficiently important in Rome to be produced in provincial centers throughout the Continent and in England, but the art was virtually lost after the collapse of the Holy Roman Empire, until it was revived for architectural and sculptural use in the late Gothic period.

The architectural use of terra cotta was important in ancient Greece, probably as a result of the development of Greek building methods from primitive wood and mud brick forms. This use continued into the period of Greek architecture, when elaborately decorated gutters, antefixes, and water spouts were made of the material, as well as the alternating round and flat tiles of roofs. The ancient Persians and Assyrians, who never developed access to stone as the Greeks did, also made elaborate use of tile, especially to face mud brick walls. In modern times, when a surface from which city grime may be easily removed presents an advantage, glazed terra cotta has been used occasionally to face buildings. A fine example is Raymond Hood's elaborate decorative treatment on the American Radiator Building in New York City.

A clay object may be baked or modeled, but, if it is above a few inches in size, it is considered necessary to scoop out the inside of the heavier masses to provide a wall of as uniform thickness as possible, because shrinkages in drying and baking may cause warping and breakage. Terra cotta may be produced cheaply in quantity by making a baked clay or plaster mold of the original model, into which clay may repeatedly be pressed or poured at the proper consistency. The charming Tanagra figurines of the Hellenistic period were made in this manner. Because of technical difficulties in the firing process, it is now considered impossible to create clay sculpture larger than table size. However, at the dawn of Western Mediterranean history, the Etruscans made many large terra cottas, and a fine Etruscan figure of a warrior in the Metropolitan Museum, New York, is over life-size.

In the early Italian Renaissance a great deal of sculpture, in both glazed and biscuit terra cotta, was made to fill the widespread demand for art on the part of many small patrons of limited means. Luca della Robbia (c. 1400-1482) developed a style of glazed terra cotta, generally using white figures in relief against a blue background, surrounded by a panel of bright, naturally colored flowers and fruit. The style was continued by his descendants, with increasing elaboration, for a hundred years. French Rococo sculptors designed many small, gay figures and groups for reproduction in biscuit or glazed terra cotta at the national potteries of Sèvres, and this type of work, produced in various other centers of Europe, remained popular throughout the nineteenth century. *See also* ENGINEERING MATERIALS (*Brick and Clay Products*).

L. R.

**TERRAMYCIN.** *See* ANTIBIOTICS.

**TERRAPIN,** a variously spelled word, reputedly of Amerindian derivation, applied confusingly to many types of turtles, but most often to terrestrial tortoises or, contrariwise, to edible, fresh- or brackish-water species. British herpetologists subscribe to the latter usage, applying the term to any member of the Emydidae, or pond turtles. American herpetologists generally restrict it to the diamondbacks, *Malaclemys,* of the Atlantic and Gulf Coast salt marshes. The famous terrapin stew of epicures is obtained from the diamondbacks. Other excellent edible species are the cooters, of the genus *Pseudemys,* which frequent fresh-water rivers in the southeastern section of the United States. M. G. N.

**TERREBONNE** [tɛ′rbɔ′n], a town in Terrebonne Co., Quebec, Canada, situated on the north bank of Rivière des Milles Iles, 15 mi. north of Montreal, on Provincial Highways 18 and 29. It is connected by a bridge with St. François-de-Sales on Jesus Island and is served by the Canadian Pacific Railway. The seigneury of Terrebonne was granted in 1673, and the parish was founded in 1727. Incorporation as a village occurred in 1853 and as a town in 1860. The town was for many years the headquarters of the fur trade. Local manufactures include agricultural implements, machine tools, shoes, steel and fiber products, and sashes and doors. Pop. 1951, 3,200. D. F. P.

**TERRE HAUTE** [tɛ′rə ho′t], a city in western Indiana, the county seat of Vigo Co., situated on a plateau on the east bank of the Wabash River, 72 mi. southwest of Indianapolis. Coal mines and clay and shale deposits are in the vicinity. Terre Haute is the commercial and financial center of the surrounding coal-mining and farming area. A settlement started around Fort Harrison, erected at the beginning of the War of 1812, about 3 mi. north of the present city. Terre Haute was incorporated as a town in 1816 and chartered as a city in 1853. The city is administered by a mayor and council. The Chicago & Eastern Illinois, the Chicago, Milwaukee, St. Paul and Pacific, the New York Central, and the Pennsylvania railroads and the Trans-World Airlines provide transportation. Terre Haute's diversified plants include railroad shops, paper mills, distilleries, foundry and machine shops, and flour and grist mills. Penicillin, chemicals, solvents, men's clothing, distilled spirits, vitrified brick, tile, coke, enamelware, and bottles are produced in the city. Pop. 1950, 64,214.

**TERRELL** [tɛ′rəl], a city in Kaufman Co., in northeastern Texas, situated 35 mi. east of Dallas. It is a retail trade center for an agricultural area. Terrell was founded in 1873 and incorporated in 1885. It is administered by a council and city manager. It is the seat of Terrell State Hospital and Texas Military College. The Texas and Pacific and the Southern Pacific railroads provide transportation. The manufacture of flour and cottonseed oil and the ginning and baling of cotton are leading industries. Terrell also has creameries, candy and broom factories, planing mills, and machinery plants. Pop. 1950, 11,544.

**TERRESTRIAL MAGNETISM AND TERRESTRIAL ELECTRICITY.** Terrestrial magnetism, or geomagnetism, deals with the magnetic phenomena of the earth, which acts as a great spherical magnet. Terrestrial electricity deals with the electrical phenomena evidenced by the natural electric currents—earth currents—flowing within the earth, and by the electric field of the atmosphere—atmospheric electricity.

### HISTORY OF TERRESTRIAL MAGNETISM

**The Lodestone.** It is fortunate that there is distributed widely over the earth's surface a natural magnet in the mineral magnetite—an oxide of iron commonly designated as the lodestone. The discoveries of the lodestone's property of attracting iron and, later, that of taking a definite direction if freely suspended or floated were basic ones in realization of the geomagnetic field and of its economic applications.

Legends of "south-pointing" war chariots, now proved largely mythical by the thorough researches of A. Crichton

Mitchell, credited the Chinese with knowledge of the properties of the lodestone twenty-five centuries or more before the Christian Era. It is known, however, that by the fifth century B.C. the Greeks were aware of the property of the lodestone to induce magnetism in iron objects touching it. Thus, in Plato's dialogue *Ion,* Socrates says: "There is a divinity moving you, like that of the stone which Euripides calls a magnet. For that stone not only attracts iron rings but also imparts to them similar power of attracting other rings, suspended one from another, so as to form quite a long chain; and all of these derive their power from the original stone." Until about 1820, artificial magnets were made through this power of inducing magnetism merely, by stroking iron bars with other magnets or a lodestone. Then, the discovery that a magnetic field is produced by sending an electric current through a cylinder of many turns of wire, and that it will magnetize a bar of iron mounted within such a coil, resulted in the use of electromagnetization.

**The Compass.** About A.D. 1100, Europeans became acquainted with the directive property of the lodestone that gave birth to the invention of the magnetic compass. The polarity of the lodestone (or of a magnet made by its induction), its directive property in the geomagnetic field, and its application to navigation were first described by Alexander Neckam about 1187, in two treatises, *De utensilibus* and *De rerum naturis.* The first of these includes a description of the use of a magnetized needle to indicate the north, and the second gives the method of mounting such a needle on a pivot.

In 1269, Petrus Peregrinus de Maricourt wrote on his experimental results with a spherical lodestone and explained how the poles or centers of magnetic strength thereof could be determined. He mounted his lodestone in a floating wooden cup and noted that the stone would cause the floating cup to turn "until the north pole of the stone would come to rest in the direction of the north pole of the heavens." He observed further that no matter how often the cup was moved away from this direction, the lodestone would always cause it to return "by the will of God." He found, on cutting a lodestone in two parts, that each part became a magnet with two poles and that when these were put together again the two poles in the center disappeared.

The next major step in the history of terrestrial magnetism was the discovery that the direction assumed by a compass changes from place to place. The actual date of this discovery is uncertain, and it was not until 1581 that this fact appeared in print in an article by Robert Norman on *The Newe Attractive.* In 1576, Norman had also discovered that when a magnetized needle is mounted in a horizontal axle one end will dip below the horizon. The discoveries of these facts of magnetic declination and inclination led, before the end of the sixteenth century, to the first real recognition of the earth's behavior as a great magnet.

**Gilbert's Theory.** In 1600, William Gilbert, court physician to Queen Elizabeth, published *De magnete,* in which he summarized knowledge of the properties of magnetic bodies and advanced his epoch-making conception of the earth as a great magnet, thus antedating Newton's theory of universal gravitation by nearly a century. The conclusions were based on many experiments made with spherical lodestones and a small magnetic needle. Gilbert's theory explained the north-south position of the magnetic needle and, assuming the axis of magnetization to coincide with the axis of rotation of the earth, the change of geomagnetic dip or inclination with latitude. Gilbert also noted the influence of the lodestone at a distance and called the field of a magnet *orbis virtutis* (circle of power). There is no doubt that he was stimulated in his thinking by the earlier work of Norman, who had expressed the idea of a magnetic field as the "vertu extending rounde about the stone in great compasse." Gilbert's work is an outstanding contribution to magnetic science and is distinguished by adherence to the scientific method of investigation by experiment.

Soon the complexity was added to by the discovery that the compass direction at any fixed place undergoes a long-time, or secular, change. This fact was first noted by Henry Gellibrand in 1634.

**Early Geomagnetic Surveys.** Naturally, Gilbert's conclusions enlisted the efforts of many explorers and investigators in obtaining geomagnetic data in all parts of the known world. Among the possible applications, it was thought that the problem of determining longitude, for which chronometers were then not available, might be determined by the changes in magnetic variation, that is, direction or declination. This supposition led to the inception of a geomagnetic oceanic survey of the north and south Atlantic Ocean by Edmund Halley on the *Paramour* during 1698 to 1701, under the auspices of the British government, "to improve the longitude and variations of the compass." Halley originated the method of portraying by isomagnetic curves—lines along which values are equal—the distribution of the geomagnetic elements, although he used it only for declination. This classic chart was printed in 1700. Wilcke's chart of geomagnetic inclination was published in 1768. Charts delineating geomagnetic directive force resulted from Humboldt's observations on his American journeys during 1799 to 1804. These were the forerunners of the geomagnetic world charts now issued at regular intervals by the leading hydrographic bureaus.

The gradual improvement in understanding was integrated from the researches of many investigators. In *Untersuchungen über den Magnetismus der Erde,* Christopher Hansteen published, in 1819, a history of magnetic observations up to about 1800 with tables of results to 1819. This work was accompanied by a magnetic atlas showing changes in geomagnetism since 1600.

Perhaps the greatest fundamental advance since Gilbert's theory was that resulting from the investigations of C. F. Gauss and his colleague, W. Weber. Gauss developed the technique to determine the intensity of the geomagnetic field, published in 1832, in a system of absolute units involving length, mass, and time. The unit of this so-called centimeter-gram-second (C.G.S.) system is designated as the gauss (Γ); for convenience, a smaller unit is used and designated gamma (γ), equal to 0.00001 gauss.

## THE GEOMAGNETIC FIELD AND SURVEYS

**Main Field.** The earth's magnetic field extends far out into space, falling off inversely as the cube of distance; for example, 4,000 mi. above the earth it is one-eighth as great as at the surface. Upper-air observations of the geomagnetic elements, as well as below the surface of land and sea, are needed, because the regular and irregular changes may undergo considerable modification with change in altitude. Developments in instrumental technique during World War II have made feasible extensive and accurate surveys by aircraft.

The analyses of geomagnetic world surveys on the surface indicate the value of the earth's magnetic moment, $M$, to be $8 \times 10^{25}$ C.G.S. units, of which about 95 per cent is attributable to forces beneath the surface of the earth. The remainder, in one minor portion, is attributable to forces above the earth, and, in another, to currents passing through its crust. From

about 1847 to 1950 the intensity of this field apparently decreased at an annual rate of one fifteen-hundreth part, the average value for corresponding parallels north and south being generally larger for land-predominating, than for ocean-predominating, parallels.

**Magnetic and Geomagnetic Poles.** This magnetization is not uniformly distributed. The distribution of magnetic ore deposits and the superposition of their resulting local fields make the actually observed field a composite one. The so-called magnetic poles of this composite field are distant a thousand miles or more from the geographic poles, with the north magnetic pole approximately in 73° N. lat. and 100° W. long., the south magnetic pole in 68° S. lat. and 144° E. long. These two poles are not diametrically opposite, since the line joining them passes about 700 miles away from the center of the earth. Consideration of observations at or in the region of these poles, and of isomagnetic charts for various epochs, has raised the question of possible shifts of the poles over long periods of time.

**Magnetic Anomalies.** Irregularities of distribution of the geomagnetic field over continental areas may bear definite relation to geologic features of the earth's crust. Though these irregularities have long been recognized, it is only comparatively recently that they have been intensively considered as an aid in the study of geologic substructure. The random distribution of magnetic ore deposits in the crust of the earth produces so-called magnetic anomalies. Some of these are quite small and intense, with magnetic effects limited to a few square miles; for example, near Juneau, Alaska, where in a small area the declination is reversed. Others, like those in the U.S.S.R. at Kursk, in Germany at Berggiesshübel, and in southern Transvaal at the Pilansberg dike system, cause irregularities of magnetic intensity twice or even three times the normal value. At Pilansberg in 1938, fourteen vertical dikes were found to be strongly magnetized in a direction opposite to the normal geomagnetic field. Such anomalies must have counterparts in the great oceanic basins. Observations in isolated islands and island groups almost invariably indicate abnormal magnetic conditions.

**Magnetic Surveys and Charts.** The delineation of the geomagnetic field is determined by magnetic surveys. Measurements to determine that field at any point must include observations of the three elements: (1) magnetic declination ($D$), the angle between the true astronomic north-south meridional plane and the vertical plane through the magnetic north-south direction, as defined by the compass; (2) magnetic inclination or dip ($I$), the angle through which a magnet wholly free to move would dip below the horizon in the magnetic north-south meridional plane; and (3) the total magnetic force ($F$), acting in the magnetic meridional plane, or the horizontal ($H$) or vertical ($Z$) component of that force.

The values of $D$ are determined by observing (a) the direction, on a horizontal circle graduated in arc, taken by a magnet free to turn about a vertical axis, and (b) the true astronomic direction on the same circle through observations of the sun or on a star. These observations may be made with an ordinary pivoted compass or by a magnetometer and astronomic telescope (both mounted in the same alidade) in which the magnet is suspended by an extremely fine fiber of silk, bronze, or quartz. A dip circle or an earth inductor is used to determine $I$. The dip circle is essentially a magnetic needle mounted so that it is free to turn about a horizontal axis. An earth inductor, which is more precise, is essentially a closed coil of wire that is rotated in the earth's field about an axis in the plane of the coil; when rotated, an electric current is induced in the windings of the coil, except that when the rotating axis is orientated in the magnetic north-south meridional plane in the direction of $F$ no current is induced. The intensity ($H$) is usually determined through measurement of the angle of deflection of an auxiliary freely suspended magnet in a magnetometer by another magnet mounted perpendicularly to it. Electromagnetic instruments, depending on measurements of electric currents induced in rotating coils of wire in the earth's field, give more accurate values of $F$, $H$, or $I$ and have come into more general use since about 1930.

The motion of a surface vessel or an aircraft makes observations at sea or in the air more difficult. Gimbal suspensions are used, and until about 1920 instruments for oceanic surveys were of the magnetic type in principle but with appropriate modifications from those used on land. The development of electromagnetic instruments since that time has made more accurate determinations possible both at sea and in the air.

Following partial and scattered surveys on land in earlier times, and those of Halley at sea, many surveys over the continents and oceans were made by various governments. These culminated in the first general world magnetic survey of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, through some 150 expeditions in magnetically unexplored regions, between 1905 and 1940, and in cruises of the brigantine *Galilee* and of the specially constructed non-magnetic yacht *Carnegie,* between 1905 and 1920, over nearly 350,000 nautical miles in all oceans between 80° N. lat and 60° S. lat. Instruments of latest types were used, and the data obtained were of greater accuracy than any previously determined. The latest published isomagnetic charts are based upon an extensive discussion and analysis of this survey and of data obtained at established world-wide magnetic observatories.

**Magnetic Observatories.** In view of the regular and irregular variations of the earth's magnetic field, the data obtained at fixed magnetic observatories are essential in the world magnetic survey and investigations. Early in the nineteenth century, under the stimulus of the theoretical studies of Gauss and his colleagues and predecessors, the first observatories continuously recording the changes in the geomagnetic elements were set up. In 1947, there were some 70 established observatories. The polar regions, though including only one-seventh of the earth's surface, are unique because of the proximity of the poles and because of the great changes in the magnetic field there in short distances and short intervals of time.

## CHANGES OF GEOMAGNETIC FIELD— REGULAR AND IRREGULAR

**Secular Variation and Isoporic Charts.** The comparison for different epochs of isomagnetic charts, or of results at a single station, shows slow changes taking place in all geomagnetic elements. The importance in practical use of the magnetic compass is evidenced by actual observations made at London. There, the magnetic needle pointed 11° east of north in 1580, gradually changed to 24° west of north in 1812, and then shifted until it was 10° west of north in 1947. Secular-variation data at stations in other parts of the world show different periods and amplitudes; hence the popular explanation that such changes result wholly or mainly by shift in position of the geomagnetic axis, or poles, of the earth must be dismissed as insufficient.

On assembly of data, the shifts of isomagnetic lines are determined for successive years. An isoporic chart is one

showing lines along which the isomagnetics make the same annual progress. That changes are still taking place within the earth is indicated by these varying isopors, by the slow expansion and then gradual retraction of the areas in which there have been large alterations in any of the elements, and by the irregular drift in position with the years of the foci of maximum and minimum.

Since about 1939, investigators have sought to extend knowledge of secular variation, over a longer time scale than is available from recorded observations, through paleomagnetic research. This is the determination of what may be called "fossil magnetization" of cores of material collected at the bottoms of the oceans and of varves (layers of silt), deposited during the last Ice Age about 30,000 years ago. Work done on varves prior to World War II indicated that changes in declination and inclination varied similarly to those observed since early in the sixteenth century. A preliminary determination in 1946 of the intensity of magnetization of varves deposited in New England during the last Ice Age showed that the behavior of the magnetic intensity of the earth was unchanged for 30,000 years, within the accuracy of the measurement.

**Diurnal and Other Regular Variations.** The second important change with time in geomagnetism—the solar diurnal variation—was discovered by George Graham in 1722 at London. This is a 24-hour variation, progressing according to local mean time. It changes with season, having a greater amplitude in summer than in winter; is opposite in the Northern and Southern Hemispheres; is more pronounced near the poles; varies with the state of activity of the earth's field; and is modified in character with changes in the frequency of sunspots, that is, with the cycle of variation in solar activity.

There is also an annual, though generally small, cycle of variation, which should not be confused with the secular or annual change of mean values. Its cause appears to be outside the earth.

Another quite small but systematic variation is that associated with the moon's position, which was discovered by K. Kreil in 1850. It is related to the lunar day, which on the average is 50 min. longer than the solar day. Its magnitude is less than one-tenth that of the solar diurnal variation. It has a double wave during the lunar day of 24 hours and is the most conspicuous lunar effect on the earth apart from the oceanic tides.

**Irregular Variations and Magnetic Activity.** In addition to the progressive and regular variations of geomagnetism, there are irregular ones of many kinds which are generally classed as magnetic storms or perturbations. These frequently take place simultaneously, or nearly so, over the whole globe and are generally more pronounced in the regions about the poles. One form begins abruptly, with no preliminary indication, and is named "sudden commencement." Another of less irregular form, extending over 30 min. or more, is bay-like and therefore carries the designation "bay." There are storms of prolonged duration, sometimes over several days, the photographic records of which show innumerable irregular fluctuations before gradually returning to a normal state following a low-value period—somewhat like the behavior of a Leyden jar after discharge. Magnetic-storm periods are frequently accompanied by greater or lesser displays of polar lights and irregular changes in the natural electric currents flowing in the earth; they wax and wane with the number and size of sunspots or other evidence of solar activity.

These quasi-regular and irregular conditions are measures of the earth's magnetic activity, that is, its general state of magnetic rest or unrest. There are several ways to define geomagnetic activity quantitatively. The simplest, adopted in 1906, is the daily international magnetic character figure. Each observatory, from inspection of a day's records, assigns to each 24 hours between successive Greenwich midnights a character figure on a scale of 0, 1, and 2. A quiet magnetic day is rated 0, a moderately disturbed day 1, and a greatly disturbed day 2. The adopted daily values ($C$), to the nearest 0.1, are the averages as assigned at various observatories. The use of mean values of $C$ from 40 to 50 world-wide observatories established correlations between geomagnetic activity and other geophysical phenomena. One example is the tendency to a 27-day recurrence in magnetic storms and relation to rotation of disturbed regions of the sun, designated as $M$ regions.

Two other somewhat more objective measures of geomagnetic activity are the so-called $u$ measure and the 3-hour-range index ($K$). The former depends on the average difference, regardless of sign, in the force directing the compass between successive daily means. The latter was introduced internationally about 1939 to meet the need of a homogeneous running record of solar corpuscular radiation, by measuring the intensity of geomagnetic activity resulting from electric currents produced around the earth by that radiation. Intrinsically, $K$ is a measure for eight 3-hour intervals for each Greenwich-mean-time day from 0 to 24 hours, on a scale of 0 to 9 for the difference on normal records at each observatory. Values of $K$ are quite useful in determining correlations with phenomena in the high atmosphere.

## COSMIC RELATIONS

**Solar Relations.** Observations of variations in the activity of sunspots and of the earth's magnetic field over more than a century, at stations in Europe and North America, show close parallelism from year to year during a solar 11-year cycle. As the earth revolves around the sun during the year, there are geomagnetic fluctuations with maxima during the equinoctial months of March and September and minima during the solstitial months of June and December.

**Polar-Light Relation.** Minute electrified particles or corpuscles coming continually from the sun are entrapped by the geomagnetic lines of force reaching far into space. They are made to travel spirally around those lines where the lines are steepest—in the regions above the poles—and become luminescent because of the atmosphere's resistance as they penetrate deeper. As a result, there are polar lights, visible most frequently in the polar zones but sometimes, during great magnetic storms, visible in the temperate and even the torrid zones. Photographs of auroras made simultaneously from two stations at a measured distance apart show that polar-light beams generally do not come closer to the earth's surface than about 60 miles; some are observed to heights of 300 miles or more.

**Ionospheric Relation.** A hypothesis, based on geomagnetic data, on the existence of an electrified outer atmosphere —the ionosphere—was made about 1882 by Balfour Stewart. Gauss in 1838 had forecast this as a possible result of future study of the regular diurnal and irregular changes of the geomagnetic field. Stewart concluded from a discussion of the diurnal magnetic varations that they originate in the upper atmospheric layers and that these layers must conduct electricity much better than the almost nonconducting air near the earth's surface. The mathematical verification of these basic ideas, indicating ultraviolet radiation as the ionizer or electrifying agent, was made by A. Schuster about 1889.

E. V. Appleton and M. A. F. Barnett of England and G. Breit and M. A. Tuve of the United States observed directly

in 1925, by radio pulse waves, the ionized layers of the outer atmosphere. Instrumental technique was soon thereafter developed by which continuous automatic photographic records could be made of the electrification of the three ionospheric regions. These regions are known technically as the *E* region at about an average of 60 miles above the earth's surface, the *F*1 region at about 130 miles, and the *F*2 region at about 185 miles. From such data was developed the magneto-ionic theory, which has been completely confirmed experimentally. This theory provides for exact measurement of electron densities at various levels, including atmospheric regions far from the earth, by the use of radio waves. The geomagnetic field was essential in this development.

As was first pointed out by J. H. Dellinger in 1935, radio fade-outs or blackouts frequently coincide with bright eruptions or flares in the solar chromosphere and with geomagnetic changes of unique character associated with an increase of diurnal variation. Actual photographic records of a fade-out and simultaneous characteristic geomagnetic and solar-flare effects, first obtained in 1937, made the physical relationship conspicuously certain.

**Cosmic-Ray Relations.** Active research on penetrating radiation—cosmic rays—began with the work of J. Elster and H. Geitel and of C. T. R. Wilson in 1900 and 1901. Wilson showed that enclosed dry air is not a perfect electrical insulator and has a weak conductivity. Investigations of available cosmic-ray data by A. Göckel in 1911 and by V. F. Hess and others shortly afterward proved that cosmic-ray intensity increases with altitude, indicating origin outside the earth rather than inside it, as previously thought.

## TERRESTRIAL ELECTRICITY

Terrestrial electricity, or geoelectricity, has to do with those natural electric phenomena which occur within the earth—earth currents—and those which are found in the atmosphere of the earth—atmospheric electricity.

Natural earth currents were originally measured by W. H. Barlow in 1847, although Sir Humphry Davy suggested them in 1821 and M. Faraday, though unsuccessful in attempts to observe them, was confident that they existed. These currents circulate in the crust of the earth and are generally weak, but in times of disturbances they may attain strength sufficient to interfere seriously with telegraphic transmission. These currents and the atmospheric-electric phenomena may be grouped as the electric field of the earth and its atmosphere.

**Earth Currents.** It is found that earth currents constitute a world-wide system which differs from place to place, and which is subject to regular and periodic and to irregular variations, both in intensity and direction. The regular variations and disturbances show constant relationships to changes noted in other cosmic phenomena; for example, to those noted in the earth's magnetic field during displays of the aurora and during solar disturbances. The earlier attempts to measure earth currents were often contradictory, because some natural currents are purely local in character, and artificial currents like those due to leakage from power-systems are superimposed.

There is a physical connection between earth currents and the geomagnetic field, though the relation has yet to be determined. Even though earth currents may be directly produced by magnetic changes, they should have a reaction that would affect the measured variations of magnetic force with a strength of reaction depending on the internal structure of the earth. Thus, it is apparent that a simple relationship can hardly be expected. Records of diurnal variations on calm and disturbed days, from observations at Watheroo (Western Australia), Ebro (Spain), Huancayo (Peru), and Tucson (Ariz.), show small definite and distinctive differences in the magnetic variations during periods of disturbed earth currents. Seasonal changes in normal earth-current activity are quite similar to those in magnetic variations. It is safe to say that no explanation of magnetic variations can be accepted unless it suffices for earth currents.

Gradients of earth-current potential of as much as several volts per kilometer have been observed. World-wide storms, characterized by sudden commencements which occur simultaneously at widely separated stations, coincide with similar magnetic storms. The 27-day recurrence in disturbances was shown by W. J. Peters and C. E. Ennis to be a feature of earth currents, as well as of geomagnetism.

Discussions by O. H. Gish of the available data show the existence of a system of eight current whorls symmetrically spaced as regards the equator, and a secondary series of similar whorls near the North Pole. On the daylight side of the earth, the whorls are large and well defined, whereas those on the dark side are less definite. These current whorls may be considered as fixed in space under the sun, with any point on the earth occupying successive positions in them as the earth rotates. Consideration of a diagram of these whorls shows the significance of the commonly noted features of diurnal variations at middle-latitude stations generally in a longitudinal direction of current flow, the surge of current toward the equator near noon, and reversal of direction during the forenoon and afternoon.

**Atmospheric Electricity.** The classical kite experiments on the electrification of clouds and the nature of lightning by Benjamin Franklin in 1752 furnished the foundation for atmospheric electric investigations. Franklin's observations approximately coincided with those of P. C. Lemonnier in France, who showed that even under cloud-free conditions the atmosphere is the seat of an appreciable electric field. The development of the study of the electric phenomena of the atmosphere advanced somewhat after the introduction of the quadrant electrometer by Lord Kelvin, and following the work of F. Exner. Greater study and development began after the introduction by J. J. Thomson of the ionic theory of the electrical conduction in gases, and under the leadership of J. Elster and H. Geitel the foundations were laid for present-day investigations of the electric field. These investigations took on greater importance after 1900 because of bearings on recent theories of electricity and because of their intimate association and correlations with geomagnetic phenomena, with which strong parallelism as regards space and time distribution and variations was found. The range and perturbations of electric diurnal variations are much greater than those for magnetic elements, and more dependent on meteorological conditions, but the change of absolute values with geographic position is not so great.

In general, the atmospheric-electric phenomena observed include potential gradient, conductivity, and ionization. On clear days the earth is negatively charged with respect to the air, and in the lower layers of the atmosphere the difference in potential between the earth and a point in the atmosphere increases with its height above the earth. The change in potential per meter is defined as potential gradient; under good meteorological conditions, its average value determined at many stations on land and sea is on the order of 130 volts per meter at sea level; that is, the potential of the air one meter above the ground is 130 volts higher than the potential of the ground. Observation shows that, in general, the gradient decreases with land altitude; for example, its value at the Huancayo magnetic observatory, at 11,000 ft. above sea level,

is about 50 volts per meter. On the other hand, the conductivity increases with altitude. Fair-weather values of the negative and positive conductivities of the lower atmosphere are of the order of $10^{-4}$ electrostatic unit (e.s.u.), the positive conductivity being in general 10 to 20 per cent larger than the negative conductivity. Observations of ionic content indicate average values ranging from 500 to 1,000 ions (of either sign) per cubic centimeter, the number of positive ions being about 20 per cent greater, thus leaving a volume charge in the atmosphere amounting to several hundred free positive ions per cubic centimeter. Values of the air-earth current density, from simultaneous observations of potential gradient and conductivity, are of the order of $10^{-6}$ e.s.u., the value being somewhat greater over land than over sea.

From discussions and analysis of the atmospheric-electric observation at sea on the *Carnegie* from 1915 to 1921, S. J. Mauchly found that the chief component of the diurnal variation of the potential gradient is a 24-hour wave occurring simultaneously in the same phase in all localities. It was found from consideration of observations on land that, in general, this 24-hour wave progresses also approximately according to universal time over the entire land surface of the earth. The greatest value of the gradient occurs at an average during the year between $17^h$ and $19^h$ universal time, which is approximately the time when the sun is in the meridian of the north magnetic pole of the earth. Possibly this fact indicates a close relationship between the magnetic and electric fields; thus far, the character of this relationship is unexplained. On the Arctic Drift expedition of Roald Amundsen during the three winters from 1922 to 1925, H. U. Sverdrup made a series of observations that confirmed this fundamental deduction. The data obtained for density of air-earth current from simultaneous potential-gradient and conductivity results at sea show also that atmospheric-electric phenomena can not be interpreted wholly on the basis of local conditions, however characteristic such features may be.

There is some evidence that the annual variation of atmospheric potential gradient progresses according to time of year rather than according to local seasons, which is significant from the viewpoint of solar relationship; the maxima of activity also occur near the equinoctial months, March and September, and the minima of activity near the solstitial months of June and September, corresponding as well to the fluctuations in earth-current activity and in the frequency of the northern lights. The gradual increase of the potential from the equator to 60° N. lat. and 60° S. lat. again suggests the world-wide predominance of the chief features of this element.

The conductivity and the potential gradient set up an electric conduction current. The value of this current, as derived from measurements, shows an average density $11 \times 10^{-7}$ e.s.u. per square centimeter, or $3.7 \times 10^{-6}$ amp. per square centimeter, and flows from air to earth except on rare occasions. For the whole earth, this would amount to a total current of 1,800 amp. The observations that provide a measure of the conduction-current density show that negative electricity is supplied to the earth and that positive electricity is supplied to the higher strata of the atmosphere by a process which neither increases nor decreases through many years, but which may fluctuate from year to year and from season to season, and which varies in a fairly regular manner during the day. It is estimated that thunderstorms in progress at any time on the whole earth give $2 \times 10^9$ kw. of power, whereas the power required to maintain the total fair-weather conduction current of about 1,800 amp. between the high strata of the atmosphere and the earth is about $6 \times 10^5$ kw. Thunderstorms occur most frequently at about the time of the Greenwich day when the atmosphere's potential gradient is greatest. This relation is the only basis of any theory that may account for the maintenance of the electric charge of the earth, despite the constant current of the air from the surface.

### THEORIES ON ORIGIN OF TERRESTRIAL MAGNETISM AND ELECTRICITY

The magnetic field of the earth is delineated and known with some accuracy. The origin and nature of its short-time variations are well understood, and many can be predicted reasonably well. The cause of the main part—some 95 per cent or more—of the large magnetic moment of the earth is still unknown. The cause maintaining the earth's electric charge, despite the constant current of thousands of amperes from the air to the surface, is the second large outstanding problem.

The connecting link, if any, between the geomagnetic and the atmospheric-electric phenomena is very loose. The latter depend largely, at any one region, on local circumstances of topography, of meteorology, and of climatology. Terrestrial magnetism, though connected in some degree with geologic structure, is found to be largely independent of local conditions. The fundamental difference is that the chief variations of atmospheric electricity originate in the lower 12 to 15 miles of the atmosphere, whereas those in terrestrial magnetism are produced by electric phenomena in the ionosphere at 60 to 185 miles—a region most greatly affected by solar and cosmic influences.

Theories as to magnetic diurnal variation satisfactorily ascribe the internal part of the variation field to currents induced within the earth. Most theories concerning magnetic perturbations attribute them to the action of corpuscular radiations from the sun and induction of currents by dyamo action, as outlined by S. Chapman in 1918.

In 1947, P. M. S. Blackett revived the earlier ideas of W. Sutherland and A. Schuster that the magnetic moment ($P$) and angular momentum ($U$) of massive bodies are nearly proportional to the square root of the gravitational constant ($G$) divided by the velocity of light ($c$). This revival followed H. D. Babcock's spectrographic determination in 1947 of the magnetic field of the rapidly rotating star 78 Virginis. From this result, and from the magnetic field of the sun determined, in 1913, by G. E. Hale, Brackett expresses the relation:

$$P = \beta(G/c)U,$$

where $\beta$ is a constant of the order of unity. The polar magnetic fields are 0.6, 53, and 1,500 Gauss for the earth, the sun, and 78 Virginis, respectively.

The hypothesis that any body becomes magnetic on rotation was tested experimentally in the laboratory by S. J. Barnett, who concluded, in 1933, that a sphere rotating in a nonmagnetic field does become magnetic but in far too small a degree to account for either the earth's main field or that of the sun. The observed relation expressed in the above formula for the magnetic fields of three massive rotating bodies focuses attention on the possibility that the geomagnetic field does arise because of the greatness and rotation of the earth. *See also* AURORA BOREALIS AND AURORA AUSTRALIS; COSMIC RAYS; ELECTRICITY AND MAGNETISM; MAGNET; METEOROLOGY; SOLAR SYSTEM.

J. A. F.

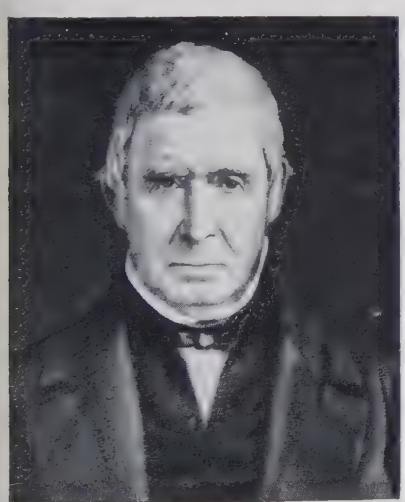
**TERRIER.** *See* DOG.

**TERROR, MOUNT,** an extinct volcano on Ross Island, at 77° 30′ S. lat. and 168° 40′ E. long. This mountain,

10,750 ft. high, and near-by Mount Erebus (13,200 ft.), an active volcano, were named after the two ships, *Terror* and *Erebus,* of the expedition (1839-1843) commanded by James Clark Ross when he discovered the Ross Sea entrance to the Antarctic Continent. Mount Terror, visible above the outermost edge of the Ross Shelf Ice, has been used as a landmark for ships sailing the Ross Sea west of Ross Island.

H. J. W.

**TERRY,** the name of a family of American clockmakers, of whom the most noted were Eli Terry (1772-1852) and his son, Silas Burnham Terry (1807-1876). Eli Terry was born in East Windsor, Conn., Apr. 13, 1772. After serving an apprenticeship under Daniel Burnap, the clockmaker, Terry established himself in East Windsor in 1792. Here he produced his first clocks, utilizing both brass and wood movements. He moved to Northbury (now Plymouth), Conn., in 1793, and in 1797 received a United States patent on an "equation" clock. Terry evolved the idea of mass-producing clocks and by 1800 was making wooden movements in quantity by cutting parts with water-powered saws. He perfected his manufacturing techniques and in 1808 turned out 4,000 wooden-movement wall clocks for a Waterbury firm. In 1814 Terry received a patent on the original form of his famous "Pillar and Scroll" shelf clock; a later version of this design sold in the thousands, bringing him wealth and fame. He retired from active business in 1834 and devoted the rest of his life to research and development in the field of clock movements. Terry was granted nine United States patents for his various horological inventions. He died in Terryville, Conn., Feb. 24, 1852. He was the father of eleven children,



*ELI TERRY*

BROWN BROTHERS

three of whom, Eli, Henry, and Silas, were also prominent clockmakers.

Silas Burnham Terry (1807-1876) was born in Plymouth, Conn., Feb. 1, 1807. He learned the fundamentals of clockmaking from his father and by 1824 had established his own clock factory. Unlike his father, he did little work in wood, preferring to mass-produce brass-movement clocks. Most American clocks of that period were powered by a controlled fall of weights, but in November 1830 Silas Terry received a United States patent on a coiled-spring power unit. He also invented clock-making machinery. His inventions and improvements did much to benefit American clockmaking. Silas Terry died in Winsted, Conn., May 20, 1876. B. P.

**TERRY, ELLEN ALICIA** or **ALICE** (1847-1928), English actress, was born in Coventry on Feb. 27, 1847. Brought up by parents active in the theatre, she made her stage debut in London in 1856 and soon became a great favorite. She joined Henry Irving in 1867, starring for many years in his elaborate productions at the London Lyceum, and touring the United States with him. Her favorite roles were the heroines of Shakespeare. She had three husbands: George Frederick Watts, the painter; Charles Claverine Wardell, an

*ELLEN TERRY*

CULVER SERVICE

actor known professionally as Charles Kelly; and James Carew, an American actor. Ellen Terry was the mother of Edith Craig, a writer, and Edward Gordon Craig, who became world-famous as a stage designer. Among her many friends was George Bernard Shaw, with whom she corresponded at length. After Irving's death in 1905, Ellen Terry acted under various managements. In her long career she appeared in many roles, in plays by Reade, Tennyson, Wills, and Sardou, but it is as Shakespeare's Portia that she is best remembered. England celebrated her golden jubilee at the Drury Lane in 1906, and in 1925 George V made her Dame Grand Cross of the British Empire. She died July 21, 1928, at Small Hythe, Kent.

**TERRY CLOTH.** *See* Textile Fabrics (*Cotton Fabrics*).

**TERTIARY PERIOD.** *See* Geology.

**TERTULLIAN (QUINTUS SEPTIMIUS FLORENS TERTULLIANUS)** [tɛrtʌ'lyən] (c.155-c.245), early Christian theologian, the son of a centurion, was born at Carthage before 160. After a thorough rhetorical and legal education he successfully practiced law at Rome. Converted to Christianity at an unknown date, he returned about 195 to Carthage, where he was ordained priest, probably about 200, and lived, in the words of St. Jerome, "to a decrepit age."

While Tertullian was a scholar widely read in Scripture and the Greek authors, his thirty-one extant works are largely practical and devoted to the relations of Christians to paganism, the conduct of Christians, and the refutation of heretics. Fourteen of his works are known to be lost. In his first or Roman Catholic period he refuted accusations against the Christians in *Ad nationes* (197) and *Apologeticus;* exhorted Christians in *De spectaculis, De idololatria, De cultu feminarum* and *Ad uxorem;* instructed catechumens in *De baptismo, De oratione, De poenitentia;* and denied heretics a hearing in *De praescriptione haereticorum* (c. 200). Increased rigorism marked his writings as he moved toward Montanism. The five books *Contra Mar-*

*cionem* (final edition c. 211) contain valuable information on Marcion's gnosticism, while *De anima* (probably c. 211) is the first Christian treatise on the soul. After his formal adherence to the Montanist sect (c. 212), he accused the Catholics ("Psychici") of laxity, and abounded in severity in *De fuga in persecutione* (c. 212), *De monogamia, De ieiunio* and *De pudicitia,* a protest against the Church's pardoning of adulterers and fornicators after due penance. *De pudicitia,* perhaps his last work, was occasioned by a decree of Callistus I, who was pope from 221 to 227. Eventually he founded the Tertullionists; it is virtually certain that he never returned to the Roman Church.

Tertullian's character was intensely individualistic, impetuous, uncompromising, militant; his argumentation keen, original, eloquent, if sometimes sophistic and ungracious; his style concise, clever, vigorous, often tortuous and obscure, abounding in pointed antitheses. He was long neglected, but much studied by the Humanists. In Tertullian, called the "hard African" by Bossuet, and "the Master" by St. Cyprian, modern scholars have seen the first Latin Christian writer, the inventor of a needed terminology, and the founder of Western theology. N. J. T.

**TERUEL** [terwɛ'l], capital of the province of the same name in Aragon, east central Spain.

**The City.** The city of Teruel rests on a hill overlooking the Guadalaviar or Turia River from the east, at the point where the Alfambra flows into it. The altitude is over 3,000 ft. above sea level, and the climate is marked by cool winters and an annual rainfall of around 15 in. Teruel is almost devoid of industry, depending instead on its trade with the surrounding area and its position as an administrative center.

*A street in Teruel, with the crowded buildings typical of the old city*

COURTESY OF THE SPANISH TOURIST OFFICE

The city has grown very little during the last century, and the older part of town is still enclosed within medieval walls. Pop. 1947, 18,112.

**The Province.** The province of Teruel, the southernmost in Aragon, has an area of 5,721 sq. mi. It is bounded on the west by New Castile and on the south and east by Valencia. In general the terrain is rugged, except at the northeast in the lower Ebro Plain. There are a number of sierras: San Just, Gudar, and Palomera in the middle; Albarracín in the west; and Javalambre in the south, where elevations exceed 6,000 ft. The principal rivers flowing northward into the Ebro are the Jiloca, Martín and Guadalope. The Guadalaviar is the chief stream in the south. Because of the accidented topography and the scanty rainfall, the main agricultural pursuit of the province is extensive cereal culture. Olive trees abound, wine is produced, and livestock (chiefly sheep) are pastured. Iron ore and lignite are mined. Pop. 1947, 219,518. R. G. W.

**TERYLENE.** *See* SYNTHETIC FIBERS.

**TERZA RIMA** [tɛ'rtsɑ ri'mɑ], an Italian verse form, used by Dante for the *Divine Comedy,* composed of three-line stanzas of iambic pentameter in which the middle line of each rhymes with the first and third of the following, thus: *aba, bcb, cdc.* Normally, the final stanza of each poem or each major section of the poem is a quatrain, in which the fourth line repeats the rhyme of the second line. Numerous poets have used the form in other languages. Introduced into English by Sir Thomas Wyatt, it has been used only infrequently, and best, perhaps, in Percy Bysshe Shelley's *Ode to the West Wind,* where the traditional final quatrain is changed to a couplet. In the twentieth century, Archibald MacLeish employed effectively a modified terza rima for his epic poem, *Conquistador,* in which five-stress lines are linked with assonance instead of with rhyme. R. Bn.

**TESHE LUMPO.** *See* SHIGATSE.

**TESSITURA** [tɛ'ssitu'rɑ], a term in music for the general pitch-range or "lie" of a vocal or instrumental part, disregarding isolated upper or lower extremes. The range or compass of an aria, for example, extends from its lowest to its highest note; its tessitura includes only that portion of the range frequently used. The midpoint of a tessitura is thus a center of gravity or an average, while that of a range is a geometrical center or mean. W. Li.

**TESS OF THE D'URBERVILLES** [dɜ'rbərvɪlz], a novel by Thomas Hardy, first published in 1891, at once becoming enormously popular.

A humble Dorsetshire dairymaid, Tess Durbeyfield, a descendant of the ancient D'Urberville family, is encouraged by her drunken father and her shiftless mother to aim at a "good" marriage with a wealthy young squire, Alec D'Urberville, who heartlessly seduces and deserts her. After the birth and death of her baby, Tess finds employment on a dairy farm, where Angel Clare, the son of a gentleman, falls in love with her. Chance frustrates Tess's attempt to tell Clare about her past, and they are married; when Tess eventually discloses her history to her husband, he leaves her, resigning her and her poverty-stricken family to every misfortune. In her despair Tess accepts help, at a price, from the man who had first seduced her. When her husband returns from Brazil, where he had fled, Tess feels that Alec has again wrecked her life, and in a frenzy she stabs him to death. After a few ecstatic days

of reconciliation with her husband, she is arrested, tried, convicted, and executed. " 'Justice' was done," Hardy bitterly remarks as the novel closes. C. J. W.

**TESTES** [tɛ′stiz], or male gonads, glands located in the scrotal sacs of most mammalian species. They arise in the abdominal cavity and generally descend to their scrotal position just before or shortly after birth. If a testis is retained in the abdominal cavity for a long period the gland is permanently sterilized by the increased temperature. The hormone production of undescended testes is maintained for long periods but may eventually decline.

A testis is composed of coiled, seminiferous tubules in which the sperm cells develop. Around the seminiferous tubules is the interstitial tissue, which secretes at least one substance, thought to be testosterone, having male hormone activity. This male hormone maintains the reproductive tract of the male in functional condition, and the sex organs fail to attain adult size in its absence. In addition, it causes development of the male secondary sex characteristics. *See also* MAN, FUNCTIONAL ANATOMY OF; REPRODUCTION, HUMAN. R. G.

**TESUQUE.** *See* INDIAN TRIBES, NORTH AMERICAN (*Southwest*).

**TETANUS** [tɛ′tənəs], also known as lockjaw or trismus, an acute and often fatal infectious disease characterized by tonic spasms of the voluntary muscles. It is one of the oldest known diseases and has been described by Hippocrates, whose son himself was a victim of tetanus. Tetanus was once recognized as one of the hazards of war, since it was the cause of death of a considerable percentage of the wounded.

**Cause.** Clinical manifestations of tetanus are due to a toxin produced by the growing spores of an anaerobic microorganism, *Clostridium tetani* (*Bacillus tetani*). This bacillus, found in the surface layers of the soil and in human and animal excreta, is particularly abundant in cultivated and manured fields, especially in the tropics. The vegetative forms are easily killed, but the spore-bearing forms of the bacillus are highly resistant to heat and chemicals. Ordinary boiling does not kill the spores; sun and air destroy them in about eighteen days.

The toxin produced by the tetanus bacillus is among the most potent water-soluble poisons known to man. It is carried by the bloodstream and thus reaches the ventral horn cells of the spinal cord. Infection is usually caused by contamination of wounds, burns, or lacerations with spore-bearing soil. Tetanus neonatorum (tetanus of the newborn), a highly fatal form, results from a contamination of the umbilicus. Cephalic tetanus, also a very severe form, develops from injuries about the head.

**Occurrence.** Tetanus is a world-wide disease, attacking virtually all warmblooded animals; mules and horses are among those most often affected. In man, tetanus may occur at all ages, although the greatest incidence is in boys under fifteen, in view of their greater exposure to traumatic injuries. Occupation may be a predisposing factor, as in the case of soldiers, farmers, and some industrial workers. In temperate zones, tetanus occurs more often in the warmer months, probably because of greater outdoor activity and less protective clothing.

**Symptoms.** The incubation period varies from three days to three weeks; the longer this period, the better the chance of recovery. In man, stiffness of the jaw is usually the first symptom. Restlessness, irritability, stiff neck, difficulty in swallowing, sore muscles, and an awkward gait may also be present. Later symptoms include rigidity of the neck and back muscles, difficulty in opening the jaws (trismus), profuse sweating, rigidity and contraction of the extremities, and the typical risus sardonicus—a painful, persistent grimace of the facial muscles which gives the impression of a sardonic grin. In severe cases, there is also opisthotonos—a convulsive, rigid, upward arching of the body. The mind remains clear and the temperature is often normal, but the mortality is high, exceeding 50 per cent, and is still greater in infants.

**Therapy and Prophylaxis.** Serum therapy is not always successful, since tetanus antitoxin exerts no immediate curative action, though it may help to arrest the advance of the disease. Prophylactic measures are of great importance. Passive immunization with antitetanus serum is indicated in the presence of injuries likely to have been contaminated with *C. tetani.* Since the period of passive immunity is short (seven to ten days), repeated injections are required until the wound heals. Active immunization with tetanus toxoid is conferred by several injections at intervals of three to four weeks; it is much more effective and lasting and has become routine in most armies. Children are protected by an active immunization with a tetanus-diphtheria toxoid. B. Van R.

**TETANY** [tɛ′təni], a disease complex characterized by intermittent tonic muscular spasms, especially of the hands and arms, and increased excitability of peripheral nerves.

**Causes and Occurrence.** Tetany is commonest between the ages of six months and two years. In its rare occurrence among adults it has been observed in certain digestive disorders; during pregnancy or lactation; following the inadvertent removal of the four parathyroid glands in a thyroidectomy; rarely in the course of an acute, infectious disease; in various intoxications; and after the ingestion of large doses of bicarbonate of soda (alkalosis). Experimentally it can be induced by forced respiration or overventilation of the lungs. In children there is apparently an association between tetany and rickets, both diseases having similar etiological features and occurring chiefly in the winter and spring. They are commoner among artificially fed than breast-fed infants, and are found chiefly among poorer classes. Blood calcium levels are different, however; in rickets a moderate diminution may be found, but in tetany the deficiency is marked.

**Symptoms and Treatment.** Tetanic symptoms are manifested as undue restlessness, irritability, excessive crying, and finally spasmodic phenomena, such as convulsions, carpopedal spasm, and laryngospasm. The convulsions are not unlike those of true epilepsy. Carpopedal spasm is the contraction of muscles of the hand and foot, causing these extremities to assume pathognomonic and diagnostic contractures which are frequently painful. These muscular spasms may be so intense that circulation is impeded, and hands and feet may become puffy and blue. Sometimes contracture of the lips occurs, producing the so-called "carp mouth." Laryngospasm is the most dangerous sign of tetany; at first, the child emits crowlike sounds and eventually the spasm may lead to complete closure of the larynx and respiratory block, causing death. Otherwise tetany is rarely fatal, and even without specific treatment the child usually outgrows the disease. Psychologically no mental deficiency or other impairment to the mind is elicited in the child who, as an infant, suffered tetany. Treatment during the acute phase consists in that of the underlying condition, which usually implies rickets, and of the attacks themselves. It

calls for diet regulation, breast milk, cod-liver oil, sunlight, ultraviolet radiation, and elimination of deleterious hygienic influences. Sedation, even anesthesia, for the convulsive and spasmodic attacks may be required. Calcium feedings are indicated. In chronic tetany modern therapy includes calcium feedings, vitamin $D_2$, and a synthetic compound known as dihydrotachysterol, which is irradiated ergosterol.
J. A. Br.

**TETE DE BOULE.** *See* INDIAN TRIBES, NORTH AMERICAN (*Western and Eastern Subarctic*).

**TETERNIKOV, FYODOR KUZMICH.** *See* SOLOGUB, FYODOR.

**TETHYS** [ti'thɪs], in Greek mythology, a Titaness, daughter of Uranus and Gaea and wife of Oceanus. She was the mother of innumerable river gods and ocean nymphs. *See also* TITANS.
G. E. D.

**TETON DAKOTA.** *See* INDIAN TRIBES, NORTH AMERICAN (*Plains*).

**TETRACHORD** [tɛ'trəkɔrd], the name applied by the ancient Greeks to a four-note scale bounded by an interval corresponding to our perfect fourth, as A-G-F-E. To form more extended scales, tetrachords were combined by conjunction, that is, by retaining a common note (A-G-F-E, E-D-C-B); or by disjunction, with no common note (A-G-F-E, D-C-B♭-A). When more than two tetrachords were combined, the resultant scales did not agree in different octaves unless conjunction and disjunction had been alternated. Today the term is applied to any four-tone scale segment.
J. M. Ba.

**TETRAHEDRITE** [tɛtrəhi'drait], an ore of copper and silver, is a sulphantimonide of copper, iron, zinc, and silver, $(Cu,Fe,Zn,Ag)_{12}Sb_4S_{13}$. Complete gradation exists between tetrahedrite and the sulpharsenide, tennantite. These minerals either crystallize in four-faced tetrahedrons or occur as formless masses. The color ranges from flint-gray to iron-black, but the streak is dark maroon. Tetrahedrite has no cleavage. It occurs in low- and especially in intermediate-temperature hydrothermal veins. Common associates are various lead and silver minerals. Tetrahedrite is an important ore mineral in the Idaho silver-lead district and is found in lesser amounts in mining districts in the Rocky Mountains and Mexico.
K. K. L.

**TETRASACCHARIDES.** *See* SUGAR CHEMISTRY (*Oligosaccharides*).

**TETRAZZINI, LUISA** [te'trɑttsi'ni] (1871-1940), Italian coloratura soprano, was born June 28, 1871, in Florence. After a period of study she made her operatic debut in Florence in 1895 as Inez in *L'Africaine*. She then toured Italy and South America. In 1904, after singing in Mexico, she created a sensation in San Francisco, but she was not heard in New York until 1908, when she appeared at the Manhattan Opera House as Violetta in *La Traviata*. Thereafter most of her singing, in opera and also in concert, was done in America, her final appearance being in New York in 1931. Tetrazzini died Apr. 28, 1940, in Milan.
W. Li.

**TETSCHEN.** *See* DĚČÍN.

**TETUÁN** [tetwɑ'n], the capital of Spanish Morocco and the administrative center for the Spanish possessions in North Africa, hence the residence of the Spanish High Commissioner and of the Khalifa, the deputy of the Sherifian Sultan. Tetuán, located about 25 mi. south of Ceuta with which it is connected by road and rail, nestles among the hills on the Rio Martín, 6 mi. from the Mediterranean Sea. A port at the mouth of the river, from which pirates formerly operated, has now become badly silted, but the city maintains a port on the Mediterranean Sea. The climate is hot in summer but cool in winter, with considerable rainfall which exceeds 30 in. annually.

Originally the site of the Roman town of Tamuda, Tetuán seems not to have been important in medieval times. Early in the fourteenth century it was taken and devastated by Spanish forces. Rebuilt and populated by Moslems and Jews expelled from Andalucía in the fifteenth century, it became an industrial and commercial center. In 1859, during the brief African War waged by Spain against Morocco, Tetuán was captured by forces under General O'Donnell, who was later given the title of Duque de Tetuán. The city, however, was returned to the Sultan in 1862 and remained under his rule until 1913, when it was again occupied by Spanish troops, this time under the terms of the Franco-Spanish agreement of Nov. 27, 1912. Pop. 1950, 78,427.
R. G. W.

**TETZEL, JOHANN** [tɛ'tsəl] (1465-1519), German Dominican priest, was born in Pirna, in Saxony. His preaching on indulgences to aid the construction of St. Peter's brought odium upon him, which painstaking scholarship has but slowly removed. In 1518, in his 106 theses, he replied to Martin Luther's 95 theses on the subject of indulgences. Tetzel's doctrine on indulgences for the living was orthodox, but Cardinal Cajetan condemned his erroneous views on indulgences for the dead. Broken in health, he retired to the monastery at Leipzig, where he died, Aug. 11, 1519, receiving an honorable burial. Modern historians have cleared him of the charges of immorality that legend had levied against him.
W. C.

**TEUCER** [tyu'sər], in Greek mythology, the name of two legendary heroes. One, the son of the river-god Scamander and the nymph Idaea, was the first king of Troy. His daughter married Dardanus, and the Trojans were sometimes called Teucrians after him. Another Teucer was the son of Telamon and Hesione and the half-brother of Ajax; he was famed as an archer among the Greeks at Troy. Upon his return home after the war, Teucer was banished by his father because of his brother's death, and, going to Cyprus, he founded there a town which he named Salamis.
G. E. D.

**TEUFELSDRÖCKH, DIOGENES** [tɔi'fəlzdrök], fictitious German professor whose biography and writings were edited by Thomas Carlyle under the title *Sartor Resartus* ("The Tailor Retailored"). Teufelsdröckh, a prophetic mystic influenced by German Idealism, believed that, if society were to be revitalized, world thought, which had become clothed in materialistic expression, should be reclothed in spiritual terms.
N. MacM.

**TEUTONIC LANGUAGES.** *See* GERMANIC.

**TEUTONIC ORDER,** also known as the Order of the Knights of the Hospital of St. Mary of the Teutons in Jerusalem, a military and religious order which originated in Acre in 1190. A number of pilgrims from Lübeck and Bremen established a hospital at Acre which soon became affiliated with the German church of St. Mary in Jerusalem.

In 1198 the Germans who had gathered for Henry VI's crusade raised the brethren of the hospital to a military order of knighthood, open only to Germans. Until 1291 headquarters were maintained at Acre, then for a few years at Venice, while bitter feuds were carried on with the other crusading orders, the Knights Templar and the Hospitalers (Knights of St. John of Jerusalem). Early in the thirteenth century the Teutonic Knights turned their attention to Prussia. First established in Transylvania as a bulwark against the Cumans, the order was reorganized by Emperor Frederick II, and the work of Christianization and Germanization was instigated on the eastern frontier. The Emperor was a generous patron, who gave the grand master, Hermann of Salza, the status of a prince of the Empire.

In 1229 the Knights, under Hermann, answered an appeal for aid from the Duke of Poland and embarked on a crusade against the heathen Slavs of Prussia. The duke gave them lands and promised them whatever they should conquer from the Prussians. In 1234 they acknowledged their holdings as fiefs of the pope but exercised virtually sovereign rights, because only a strong pope was able to exert any influence over them. Three years later the order absorbed the Livonian Brothers of the Sword, and notable progress was made after the union. During the next hundred years they gained control over the whole Baltic coast from the Pomeranian border to the Gulf of Finland, carving out fiefs for the German barons, settling German peasants on the conquered lands, and, with the Hansa, building many new towns for German merchants. After 1309 the headquarters of the order was established at Marienburg in Prussia. After reaching the apex of its power, the order began to decline when its prosperity brought a relaxation of discipline. During the latter part of the fourteenth century, Polish power revived, especially after the union with Lithuania under Jagiello. In 1410 the Polish King Ladislas inflicted a crushing defeat on the Knights at the historic Battle of Tannenberg and in 1466 West Prussia passed to Poland, although the Knights continued to hold East Prussia as a fief of the Polish crown. In 1801 the Treaty of Lunéville absorbed their possessions on the left bank of the Rhine, and Napoleon in 1809 abandoned their territories on the right bank to his allies of the Confederation of the Rhine. The order survived only in Austria and in the ancient bailiwick of Utrecht, a Protestant branch that was re-established by William I of Orange. F. C. H.

**TEVERE.** *See* TIBER.

**TEWKESBURY** [tyu'ksbəri], a municipal borough in Gloucestershire, England, at the confluence of the Avon and Severn rivers, about 90 mi. northwest of London. Tewkesbury was granted its first charter in 1107 and was incorporated in 1574. The most interesting building in Tewkesbury is the abbey church, which was consecrated in 1125 and is one of the finest examples of early Norman architecture in England. Of particular interest are the great arched western front of the church and the 132-ft.-high Norman tower. Other noteworthy features of the church are the Founder's Chapel, the Beauchamp Chantry, the tomb of Hugh le Despenser III, and the tomb of the Duke of Clarence.

Tewkesbury was the scene of the last battle of the War of the Roses on May 3, 1471, when Edward IV crushed the last remnants of the Lancastrian forces, captured Queen Margaret, and killed Edward, Prince of Wales, the Lancastrian claimant to the throne. The Nortonbury of Mrs. Dinah Craik's novel *John Halifax, Gentleman* is patterned after Tewkesbury. Boots and shoes are the chief manufactures, but milling, carpentry, and the manufacture of aircraft parts are also important. Pop. 1952, 5,446. R. W. Cr.

**TEXARKANA** [tɛ'ksɑrkæ'nə], two contiguous cities of the same name in the adjoining states of Arkansas and Texas. One, the county seat of Miller Co., is in southwestern Arkansas; the other is in Bowie Co., northeastern Texas. Officially designated Texarkana, Arkansas-Texas, the twin cities form one commercial, industrial, and social unit, but both are set up under separate civic, county, and state governments.

The Texas & Pacific Railroad reached the site in 1873 and sold town lots that year. In 1874 the Cairo and Fulton Railroad in Arkansas met the Texas road there, and it in turn sold property for development on the Arkansas side. The community was named after Texas, Arkansas, and Louisiana, the latter being included because it was thought at that time that the state boundary was just a few miles distant. The Texas section was incorporated as a city in that state in 1874, and the other community was incorporated in 1880 in Arkansas.

Although each of the two sections of the city is governed separately by a mayor and city council, Texarkana is commercially one city, and there is joint operation of many of the local services. Abundant oil and gas deposits are found in the vicinity, as well as eighteen industrial minerals, including asphalt, lime, gypsum, clay, and iron. Cotton is the chief money crop of the region around Texarkana, with truck produce second. A rail and air junction, Texarkana has service supplied by the Mid-Continent and American air lines, and by the Missouri Pacific, Texas and Pacific, Kansas City Southern, and St. Louis Southwestern railroads. The strategic location of the twin cities in the border area of four states has aided their growth as a distribution and manufacturing center. The stockyards and horse and mule markets are important in the Southwest. The diversified factory output includes lumber, railroad cars and ties, furniture, cottonseed products, steel and metal products, creosote products, mattresses, and medicines. Pop. 1950, Texarkana, Ark., 15,875; Texarkana, Tex., 24,753. S. D. M.

**TEXAS,** one of the south central states of the United States. The name is derived from Tejas, the name which the Spaniards gave to the Hasinai Indians who lived in the east-

SEAL OF THE STATE OF TEXAS

ern portion of the state. Texas is known as the Lone Star State because the flag of the state, which also served the Republic of Texas, carries a single star. Texas is bounded on the south by Mexico and the Gulf of Mexico, on the east by

Louisiana and Arkansas, on the north by Arkansas and Oklahoma, and on the north and west by New Mexico. The state has an area of 263,644 sq. mi. of land and 3,695 sq. mi. of water for a total area of 267,339 sq. mi. It is the largest of the states. Texas is divided into 254 counties; the capital city is Austin.

Texas entered the Union Dec. 29, 1845, and became the twenty-eighth state. The state motto is "Friendship"; the state flower is the bluebonnet; the state bird is the mockingbird; the state tree is the pecan; and the state song is *Texas, Our Texas,* with music by William J. Marsh and words by Marsh and Gladys Yoakum Wright.

*EL PASO, TEXAS. BEYOND THIS WESTERN TEXAS CITY LIES CIUDAD JUÁREZ, MEXICO.*

SOUTHWEST PHOTO

## PHYSICAL FEATURES

**Topography.** The surface of Texas slopes upward from the Gulf Coast toward the north, northwest, and west, the altitude varying from sea level to plateaus of more than 4,000 ft. in the extreme northwestern and western sections. The surface is generally level to rolling except in the extreme west, which is crossed by the eastern ranges of the Rocky Mountains, the chief peaks being Guadalupe (8,751 feet), Livermore or Bald (8,382), and Emory (7,835). The northern part of the state drains into the Mississippi via the Red and the Canadian-Arkansas systems. The remainder of the state drains directly into the Gulf of Mexico, the chief rivers being the Rio Grande, which forms the international boundary line for 889 mi., the Nueces, the San Antonio, the Guadalupe, the Colorado, the Brazos, the Trinity, the Neches, and the Sabine. The Sabine River forms 180 mi. of the Texas-Louisiana border.

Physiographically, Texas is the meeting place of four great physical provinces: (1) the Gulf Coastal Plains, which extend into the state 200 mi. from the eastern boundary and thence along the coast to the Lower Rio Grande Valley; (2) the Lower Western Plains, which cover north central Texas, including the Blacklands, the Grand Prairie, and the rolling plains of west central Texas; (3) the Western High Plains, which cover most of the North Texas Panhandle and extend southward to the Rio Grande and eastward as far as San Antonio, being divided into the High Plains and the Edwards Plateau; (4) the Mountain Region, which covers most of the area west of the Pecos River, known locally as the Trans-Pecos.

The long coast line of Texas provides a number of harbors, of which the most important are at Galveston, Houston, Texas City, Beaumont, Port Arthur, Corpus Christi, and Port Aransas. Houston has become a port by virtue of a 50-mi. ship channel which connects the city with the Gulf of Mexico. A number of very long and narrow islands lie close off the Texas coast, forming extensive bays and lagoons, but only Galveston Island is economically important.

**Climate.** North to south, Texas extends from subtropical to middle temperate; east to west, from humid to arid. It has a range of 74° to 56° F. in mean annual temperature, which averages 66.3° F. Mean annual rainfall ranges from 8 in. to 56 in., with an average of 30.25 in. Maritime climatic conditions predominate on the coastal plains; mountain weather in the extreme west; and continental-type weather in the area lying between. The Lower Rio Grande Valley is practically frostless, while snow averages approximately 15 in. annually over the Panhandle.

Irregular rainfall and rapid runoff in the western part of the state create an alternate deluge and dearth of water. In the years since 1930 a number of large reservoirs have been constructed for water storage, flood control, irrigation, power, and other purposes. Among the largest of these are: Lake Texoma (United States Army) on the Red River, of 5,818,200 acre-feet capacity. Whitney Dam Lake (Brazos River Conservation District) on the Brazos, with a capacity of 2,017,000 acre-feet; Lake Travis (Lower Colorado River Authority) on the Colorado, with a capacity of 1,963,000 acre-feet; Lake Buchanan (Lower Colorado River Authority) on the Colorado, with a capacity of 992,475 acre-feet; and Possum Kingdom Lake (Brazos River Conservation District) on the Brazos, with a capacity of 750,000 acre-feet. When completed, the Falcon Reservoir (Rio Grande International Boundary Commission) will have a capacity of 3,300,000

acre-feet. The underground water resources of Texas are plentiful, although the water table is receding in some areas. More than half the cities of Texas, including Houston and San Antonio, derive their water supplies from underground sources. About half the water used for irrigation comes from underground sources.

**Soils.** According to Dr. W. T. Carter of the Texas Agricultural Experiment Station there are 130 soil series and about 500 soil types in Texas. The principal soil belts include: (1) heavy clays of the coastal prairie; (2) sandy and sandy clay lands of east Texas pine and post-oak belts; (3) black limestone-origin soils of the Blackland belt; (4) thinner gray limestone soils of the Grand Prairie and the Edwards Plateau; (5) red soils of Permian origin in north central and middle west Texas; (6) fine sandy and sandy loam soils of the High Plains; and (7) the rough, stony land of the Trans-Pecos and of some broken areas in the central and southwestern parts. Rolling terrain, erratic rainfall, careless cultivation, and overstocking of pasture lands have caused considerable erosion. Most of the state is now within soil conservation districts.

**Forests.** About half the area of Texas can be classed as forest, woodland, or brush land. The principal timber belts are as follows: (1) the east Texas pine belt, which is the western extension of the southern yellow pine region, covered with longleaf, shortleaf, and loblolly pine on the sandy uplands, and with hardwoods in the valleys, including gum, magnolia, cypress, elm, hickory, sycamore, and a variety of oaks (95 per cent of the state's 1950 lumber production of 1,500,000,000 board feet was from the pine belt); (2) the post-oak belt, which stretches across the state west of the pine belt; (3) the cross timbers of north central and central Texas, of post-oak, blackjack, and other hardwoods; (4) the mesquite lands covering south, central, middle west, and north central Texas; (5) the limited timber lands of the Trans-Pecos mountain region, including Douglas fir, ponderosa pine, and Pacific white pine in limited quantities; (6) the cedar breaks extending through south central, central, and north central Texas on the western fringe of the Grand Prairies; and (7) a wide area of borderland known as the Brush Country, covered with scrub oak and mesquite, huisache, huajillo, catclaw, and other shrubs, shrub-sized trees, and prickly pear cactus. The pecan grows along streams in the central and eastern portions of the state, producing a large commercial nut crop. Both state and national governments maintain extensive forest reserves, including a large variety of trees, in Texas.

**Flora.** Native grasses covering the Texas prairies and the lighter woodlands constitute possibly the state's greatest plant-life resource, though they are of indirect value. Because of their value to livestock they have been one of the principal factors in shaping the state's economy and cultural development. There are also more than four hundred varieties of wild flowers, of which the most notable families are the asters, daisies, goldenrod, and sunflower. Both species of the bluebonnet, *Lupinus texensis* and *Lupinus subcarnosus,* growing throughout central and south Texas, are accepted as the officially adopted state flower. Varieties of the primrose, gaillardia, phlox (notably Drummond's), and coreopsis are among the most common wild flowers. Flowering shrubs include the redbud, wild plum, huisache, catclaw, and huajillo, the last two producing a peculiarly fine flavor of honey. A variety of arid-land plants is found in the western part of the state, including the maguey, or century plant, the lechuguilla, the yucca, the sotol, and many varieties of cactus.

**Fauna.** The greatest game asset is the deer, principally the Virginia white-tailed deer, which is most abundant in the brush-covered country of southwest Texas. The State Game, Fish and Oyster Commission, which administers the game laws, estimates an annual deer kill of 35,000. Other wild game includes the Sonora and mule deer, antelope, and several varieties of squirrel. The coyote is the most numerous of the predators, and the gray wolf, timber wolf, and several varieties of the cat family are found, including the cougar, ocelot, jaguarundi, and bobcat. In 1946 the State Game Commission reported 150 to 300 mountain sheep in the Trans-Pecos Mountains. Notable in song and story are the javelina (Texas peccary) and the nine-banded armadillo. Principal fur-bearing animals are the opossum, skunk, ringtail, raccoon, fox, civet, and mink. The annual fur crop varies in value from $1,000,000 to $3,000,000.

Bird life is profuse, especially among the migratory species that seasonally fly the continental meridian. The Texas gulf coast is a wintering place for ducks and geese. Wild turkey is abundant in southwest Texas. There are more than eight hundred species of birds. Notable is the mockingbird, the official state bird of Texas.

There is extensive commercial fishing in the coastal waters. The commercial crop was 20,271,878 pounds in 1946, of which the shrimp catch accounted for 15,533,034 pounds. Valuable salt-water fish include the red snapper, red fish, drum, salt-water trout, and flounder. The tarpon is plentiful and sought purely as a game fish. Fresh-water varieties include the cat, pickerel, perch, gaspergou, and buffalo. The construction of a number of large reservoirs has greatly increased fresh-water fishing. There are eleven state and six Federal fish hatcheries.

*Loading crude sulphur for shipment near Freeport, Texas. In the background is the blasted face of a yellow sulphur mountain.*

PHILIP GENDREAU

Poisonous reptiles are varieties of the rattlesnake, water moccasin, copperhead, and coral snake. The harmless horned toad, a diminutive lizard of the iguana family, is the subject of tall tales and legends.

## ECONOMIC RESOURCES AND ACTIVITIES

**Raw Materials.** The economy of Texas is characterized primarily by a large production of raw materials in excess of the state's consumption requirements. These include petroleum, natural gas, sulphur, cotton, wheat, grain sorghums, grapefruit, winter vegetables, rice, forest products, beef cattle, sheep, wool, goats, and mohair.

**Minerals and Mining.** Since 1935 Texas has consistently been the leading state in the value of minerals produced. The value of minerals produced in Texas in 1950 was approximately $2,582,000,000. Petroleum contributes most of this total. It is followed by natural gas and sulphur. Rapid development is shown by the fact that Texas minerals produced in 1900 were valued at only $5,316,222. Minerals production is widely dispersed throughout the state. Petroleum is produced in more than half of the counties of Texas, and sulphur is found in several counties along the Gulf Coast. The production and value of the principal minerals produced in Texas in 1949 was as follows:

| *Mineral* | *Production* | *Value* |
|---|---|---|
| Petroleum, *bbls.* | 743,990,000 | $1,919,494,200 |
| Natural gas, *M. cu. ft.* | 2,588,921,000 | 163,101,923 |
| Natural gasoline, *M. gals.* (1948) | 1,861,164 | 170,306,000 |
| Sulphur, *long tons* | 3,678,196 | 66,208,000 |
| Cement, *bbls.* | 12,349,219 | 24,111,833 |
| Salt, *tons* | 1,637,388 | 2,453,803 |

There was also commercial production of iron, coal, coke, copper, lead, magnesium, and various other products.

**Agriculture.** There were 384,977 farms in Texas in 1945, valued at $3,574,997,897. Owners operated 237,607 farms; tenants, 144,792; and managers, 2,578. The land had an average value of $25.29 per acre. By 1950 the number of farms had declined to 331,494 and by 1951 the value had increased to approximately $4,800,000,000. There is a great variation in farm characteristics according to region, with the average farm in some east Texas counties containing about 100 acres while the average farm in some west Texas counties may contain 10,000 acres.

The principal farming development from the Civil War to 1926 was the increase in cultivated acreage devoted primarily to cotton. In 1926 cotton acreage reached an all-time high of 17,749,000, and a record crop of 5,628,000 bales was produced. From 1927 to 1949 the cotton acreage showed a steady decline, but in 1949, although only 10,725,000 acres were harvested, a record 5,900,000-bale crop was produced. From 1930 to 1945, the number of farm tenants declined from 301,660 to 144,792. The sharecropper class of tenant declined from 105,122 to 24,507. In the same period, the total number of farms declined from 495,489 to 384,977, and the average acreage increased from 251.7 to 367.1. The farm population decreased from 2,332,693 to 1,487,829. By 1950 farm population had declined to 1,307,000. Cash receipts from farm crops in 1950 totaled $2,147,062,000. Texas ranked third in the value of agricultural products, behind Iowa and California.

Tractors and tractor equipment have played a great part in the development of modern agriculture in Texas. The number of tractors in use on Texas farms has increased from approximately 9,000 in 1920 to an estimated 250,000 in 1951.

*Irrigation.* Irrigated acreage totaled 2,884,700 in 1948. The irrigated area is distributed as follows: Panhandle High Plains, 1,384,600 acres; Pecos Valley and Trans-Pecos, 193,300 acres; West Central, 19,200 acres; Rio Grande Plain, 150,300 acres; Lower Rio Grande Valley, 592,100 acres; Coast Prairie, 525,420 acres; and other areas, 19,780 acres. An extensive irrigation project that will make use of the impounded flood waters of the Rio Grande is now being developed. This project is made possible by a treaty signed by the United States and Mexico in 1945.

LEADING TEXAS CROPS
(1950)

| *Crop* | *Acreage Harvested* | *Production* |
|---|---|---|
| Cotton lint | 6,700,000 | 2,900,000 bales |
| (1951 estimate) | 12,810,000 | 5,000,000 bales |
| Wheat | 2,839,000 | 22,712,000 bu. |
| Sorghum, grain | 6,474,000 | 148,818,000 bu. |
| Hay | 1,149,000 | 1,281,000 tons |
| Corn | 3,130,000 | 65,730,000 bu. |
| Oats | 1,386,000 | 27,027,000 bu. |
| Barley | 133,000 | 1,729,000 bu. |
| Peanuts | 490,000 | 330,750,000 lb. |

**Livestock.** Extensive grasslands made Texas a livestock region from the beginning of settlement by white men, and the prairies of south Texas were covered with wild cattle, strayed from Spanish herds, at the time of early Anglo-American immigration. Increase of cattle in Texas and demand in the North before means of transportation existed, led to the trail-driving era which culminated in the 1870's and 1880's, during which an estimated 12,000,000 cattle went from Texas up the Chisholm, Fort Dodge, and other trails.

The introduction of barbed wire ended the open range and initiated the era of large ranches, which in turn was succeeded in most parts of Texas by the crop farm and the small livestock farm. However, wide areas of west and southwest Texas, and some of the broken lands of the north central and northwest portions are best adapted to large-scale ranching; there were in 1949 a number of ranches of more than 100,000 acres each and in some wide areas the average was above 10,000 acres. Shorthorns and Herefords, crossed with Brahmas, are the predominant beef breed. Texas is the first-ranking state in number of sheep and production of wool and in number of Angora goats and production of mohair.

Total cash income from all livestock and livestock products in 1950 was $879,681,000. The United States Department of Agriculture gives the following estimate as to the number and value of livestock on Texas farms in 1951:

| *Kind* | *Number* | *Value* |
|---|---|---|
| Cattle, all | 9,260,000 | $1,314,920,000 |
| Milk cows only | 1,309,000 | 236,929,000 |
| Hogs | 1,786,000 | 43,578,000 |
| Sheep | 7,119,000 | 154,962,000 |
| Goats | 2,433,000 | 23,114,000 |
| Horses | 324,000 | 9,072,000 |
| Mules | 120,000 | 4,920,000 |
| Chickens | 25,884,000 | 29,767,000 |
| Turkeys | 755,000 | 3,775,000 |

**Manufacturing.** The refining of oil and the processing of heavy commodities close to point of production primarily for further fabrication characterize the manufacturing industry of Texas. Recent years have seen a rapid advancement in the production of consumer goods. There were 7,128 manufacturing establishments in Texas in 1947, with 297,053 wage earners receiving $755,411,000 in wages. The total value of manufactured goods in that year was $1,727,464,000.

# TEXAS

## *Index to Physical Features and Points of Interest*

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Blue, mountains, 2,217' . . . D 3
Brady, mountains . . . D 3
Cathedral, mountain, 6,860' . . . F 2
Chinati, peak, 7,730' . . . F 2
Chisos, mountains, 7,835' . . . E 1
Davis, mountains . . . F 2
Delaware, mountains . . . F 2
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(Guadalupe Peak)
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Quitman, mountains . . . F 1
Rosillo, peak, 5,420' . . . E 1
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Salmon, peak, 1,942' . . . E 2
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Santiago, mountains, 6,521' . . . E 1
Sierra Del Carmen, mountains . . . E 1
Sierra Diablo, mountains, 6,432' . . . F 2
Solitar, mountain, 1,822' . . . B 3
Tierra Vieja, mountains . . . F 2
Vieja, peak, 6,467' . . . F 2


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*Lakes, Rivers, Creeks, Bays, Straits, Seas, etc.*


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Aransas, bay . . . E 4
Baffins, bay . . . F 4
Big Canyon, creek . . . D 1
Brazos, river . . . D 4
Brownwood, lake . . . D 3
Caddo, lake . . . C 5
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Cany, creek . . . G 4
Carrizo Arroya, river . . . B 1
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Colorado, river . . . D 3
Coyanosa, draw . . . D 1
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East, bay . . . F 5
Elm, creek . . . A 5
Frio, river . . . E 3
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Guadalupe, river . . . B 4
Intracoastal, waterway . . . E 5
Kemp, lake . . . C 3
Laguna Madre, lagoon . . . F 4
Little Cypress, creek . . . F 4
Matagorda, bay . . . E 4
Medina, river . . . B 4
Mexico, gulf . . . E 5
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*Parks, Monuments, Ruins, Dams, Sites, Buildings, etc.*


Big Bend, national park . . . E 1
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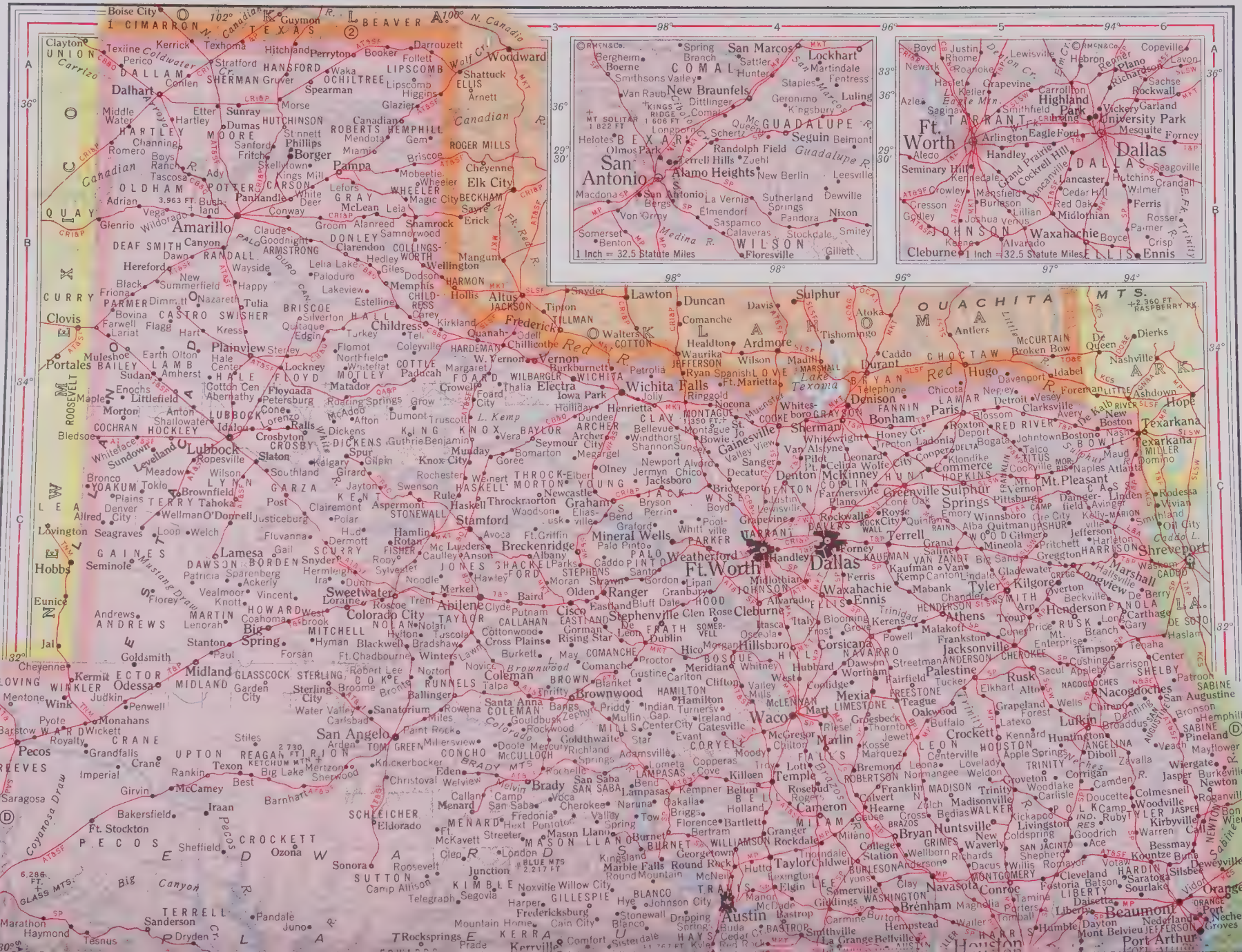
Boise City
Guymon
Dalhart
Perryton
Hitchland
Darrouzett
Woodward
Clayton
Texline
Kerrick
Texhoma
Booker
Follett
Shattuck
Stratford
Spearman
Gruver
Morse
Sunray
Dumas
Dimmitt
Hereford
Amarillo
Canyon
Claude
Wayside
Happy
Tulia
Silverton
Quitaque
Turkey
Childress
Quanah
Chillicothe
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Wichita Falls
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Henrietta
Electra
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Throckmorton
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Big Spring
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Ranger
Cisco
Eastland
Stephenville
Breckenridge
Mineral Wells
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Ft. Worth
Dallas
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McKinney
Sherman
Denison
Bonham
Paris
Texarkana
Greenville
Commerce
Sulphur Springs
Mt. Pleasant
Marshall
Longview
Tyler
Kilgore
Henderson
Jacksonville
Palestine
Rusk
Nacogdoches
Lufkin
Corsicana
Waxahachie
Ennis
Cleburne
Hillsboro
Waco
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Killeen
Belton
Georgetown
Round Rock
Austin
San Marcos
New Braunfels
San Antonio
Alamo Heights
Seguin
Luling
Lockhart
Gonzales
Cuero
Victoria
Port Lavaca
Corpus Christi
Aransas Pass
Rockport
Kingsville
Alice
Robstown
Sinton
Beeville
Bay City
Freeport
Angleton
Galveston
Texas City
Houston
Pasadena
Baytown
La Porte
Deer Park
Pearland
Alvin
Pearland
Sugar Land
Richmond
Rosenberg
Katy
Brookshire
Hempstead
Waller
Prairie View
Bellville
Brenham
Giddings
La Grange
Columbus
Wharton
El Campo
Bay City
Matagorda
Palacios
Port Lavaca
Seadrift
Rockport
Aransas Pass
Port Aransas
Corpus Christi
Kingsville
Raymondville
Harlingen
San Benito
Brownsville
Port Isabel
South Padre Island
Mission
McAllen
Pharr
Edinburg
Weslaco
Donna
Alamo
Hidalgo
Rio Grande City
Roma
Laredo
Zapata
Falfurrias
Alice
Robstown
Sinton
Beeville
Bay City
Freeport
Angleton
Galveston
Texas City
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Pasadena
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Edinburg
Weslaco
Donna
Alamo
Hidalgo
Rio Grande City
Roma
Laredo
Zapata
Falfurrias
Lubbock
Plainview
Levelland
Slaton
Brownfield
Seminole
Hobbs
Lamesa
Big Spring
Midland
Odessa
Monahans
Pecos
Fort Stockton
Sanderson
Marathon
Alpine
Marfa
Presidio
Big Bend National Park
Terlingua
Study Butte
Big Bend Ranch State Park
Lajitas
Redford
Presidio
Ojinaga
Del Rio
Eagle Pass
Piedras Negras
Uvalde
Sabinal
Hondo
Castroville
Lytle
Devine
Pleasanton
Jourdanton
Poteet
Floresville
Karnes City
Kenedy
Runge
Nixon
Gonzales
Seguin
New Braunfels
San Marcos
Lockhart
Luling
Gonzales
Cuero
Victoria
Port Lavaca
Corpus Christi
Aransas Pass
Rockport
Kingsville

LETTERS AND FIGURES IN RIGHT HAND COLUMN OF INDEX ARE THE LOCATION KEYS. THE CORRESPONDING LETTERS AND FIGURES APPEAR IN THE MAP BORDER BETWEEN LATITUDE AND LONGITUDE LINES WHICH FORM THE REFERENCE ZONES.

Statute Miles 10 0 10 20 30 40 50 60 70 80 90 100

Kilometers 10 0 10 20 40 60 80 100 120 140

Lambert Conformal Conic Projection

SCALE 1:4,096,000 1 Inch = 65 Statute Miles

FINAL 1950 CENSUS

## TEXAS

Area . . . . . 267,339 sq. m.
Population . . . 7,711,194

### KEY TO MAP SYMBOLS

- State Capital
- County Seat
- Cities over 100,000
- Size of symbols and type indicates relative population.

### CITIES AND TOWNS


Abernathy, 1,692 . . . . . C 2
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Alamo Heights, 8,000 B 4, E 3
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Alice, 16,449 . . . . . F 3
Almeda, 1,500 . . . . . F 5
Alpine, 5,261 . . . . . F 2
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Alvarado, 1,656 . . . B 5, C 4
Alvin, 3,701 . . . . . E 5, F 5
Alvord, 735 . . . . . C 4
Amarillo, 74,246 . . . . . B 2
Anahuac, 1,284 . . . E 5, F 5
Angleton, 3,399 . . . E 5, G 5
Anson, 2,708 . . . . . C 3
Aransas Pass, 5,396 . . . . F 4
Archer City, 1,901 . . . . C 3
Arlington, 7,692 . . . . . B 5
Arp, 909 . . . . . C 5
Asherton, 2,425 . . . . . E 3
Aspermont, 1,062 . . . . . C 2
Athens, 5,194 . . . . . C 5
Atlanta, 3,782 . . . . . C 5
Austin, 132,459 . . . . . D 4
Azle, 1,500 . . . . . B 5
Baird, 1,821 . . . . . C 3
Ballinger, 5,302 . . . . . D 3
Bartlett, 1,727 . . . . . D 4
Bastrop, 3,176 . . . . . D 4
Batson, 850 . . . . . D 5
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Baytown, 22,983 . . . E 5, F 5
Beaumont, 94,014 . . . . . D 5
Beeville, 9,348 . . . . . E 4
Bellaire, 10,173 . . . . . F 5
Bellville, 2,112 . . . . . E 4
Belton, 6,246 . . . . . D 4
Benavides, 3,016 . . . . . F 3
Bertram, 900 . . . . . D 3
Bessmay, 1,042 . . . . . D 6
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Bishop, 2,731 . . . . . F 4
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Blossom, 780 . . . . . C 5
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Boling, 1,250 . . . . . E 5, G 4
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Borger, 18,059 . . . . . B 2
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Brenham, 6,941 . . . . . D 4
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Brownfield, 6,161 . . . . . C 1
Brownsville, 36,066 . . . . G 4
Brownwood, 20,181 . . . . D 3
Bryan, 18,102 . . . . . D 4
Burkburnett, 4,555 . . . . . B 3
Burnet, 2,394 . . . . . D 3
Caldwell, 2,109 . . . . . D 4
Call, 1,500 . . . . . D 6
Calvert, 2,548 . . . . . D 4
Camden, 1,001 . . . . . D 5
Cameron, 5,052 . . . . . D 4
Canadian, 2,700 . . . . . B 2
Canutillo, 1,326 . . . . . E 1
Canyon, 4,364 . . . . . B 2
Carrizo Springs, 4,316 . . E 3
Carrollton, 1,610 . . . . . B 5
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Celina, 1,051 . . . . . C 4
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Centerville, 961 . . . . . D 5
Channelview, 4,500 . . . . F 5
Charlotte, 1,272 . . . . . E 3
Chico, 1,000 . . . . . C 4
Childress, 7,619 . . . . . B 2
Chillicothe, 1,415 . . . . . B 3
Chilton, 1,000 . . . . . D 4
Cisco, 5,230 . . . . . C 3
Clarendon, 2,577 . . . . . B 2
Clarksville, 4,353 . . . . . C 5
Cleburne, 12,905 . . B 5, C 4
Cleveland, 5,183 . . . . . D 5
Clifton, 1,837 . . . . . D 4
Clint, 2,000 . . . . . F 1
Clute, 1,800 . . . . . G 5
Cockrell Hill, 2,207 . . . . B 5
Coleman, 6,530 . . . . . D 3
College Station, 7,925 . . D 4
Colorado City, 6,774 . . C 2
Columbus, 2,878 . . . . . E 4
Comanche, 3,840 . . . . . D 3
Comfort, 1,200 . . . . . E 3
Commerce, 5,889 . . . . . C 5
Conroe, 7,298 . . . . . D 5
Coolidge, 1,062 . . . . . D 4
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Crowell, 1,912 . . . . . C 3
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Daingerfield, 1,668 . . . . C 5
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Dalhart, 5,918 . . . . . A 1
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Dawson, 1,107 . . . . . D 4
Dayton, 1,820 . . . . D 5, F 5
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De Kalb, 1,928 . . . . . C 5
De Leon, 2,241 . . . . . C 3
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Denison, 17,504 . . . . . C 4
Denton, 21,372 . . . . . C 4
Denver City, 1,855 . . . . C 1
Deport, 734 . . . . . C 5
Detroit, 679 . . . . . C 5
Devine, 1,672 . . . . . E 3
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Dimmitt, 1,461 . . . . . B 1
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Eden, 1,993 . . . . . D 3
Edinburg, 12,383 . . . . . F 3
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Falfurrias, 6,712 . . . . . F 3
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Ferris, 1,735 . . . . . B 5, C 4
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Fort Stockton, 4,444 . . . . . D 1
Fort Worth, 278,778
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Fostoria, 900 . . . . . D 5
Franklin, 1,209 . . . . . D 4
Frankston, 1,050 . . . . . C 5
Fredericksburg, 3,854 . . . . . D 3
Freeport, 6 012 . . . . . E 5, G 5
Freer, 2,280 . . . . . F 3
Friona, 1,202 . . . . . B 1
Gainesville, 11,246 . . . . . C 4
Galena Park, 7,186 . . . . . F 5
Galveston, 66,568 . . . . . E 5, G 5
Garciasville, 900 . . . . . F 3
Garland, 10,571 . . . . . B 6
Gatesville, 3,856 . . . . . D 4
Genoa, 1,500 . . . . . E 5, F 5
Georgetown, 4,951 . . . . . D 4
George West, 1,533 . . . . . E 3
Giddings, 2,532 . . . . . D 4
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Gladewater, 5 305 . . . . . C 5
Glen Rose, 1,254 . . . . . C 4
Goldsmith, 1,000 . . . . . D 1
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Graford, 655 . . . . . C 3
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Kingsville, 16,898 . . . . . F 4
Kirbyville, 1,150 . . . . . D 6
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McCamey, 3,121 . . . . . D 1
McGregor, 2,669 . . . . . D 4
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Meridian, 1,146 . . . . . D 4
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Mertzon, 768 . . . . . D 2
Mesquite, 1,696 . . . . . B 6
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Newton, 929 . . . . . D 6
New Waverly, 1,000 . . . . . D 5
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Oakwood, 759 . . . . . D 5
Odem, 1,680 . . . . . F 4
Odessa, 29,495 . . . . . D 1
O'Donnell, 1,473 . . . . . C 2
Olmos Park, 2,841 . . . . . B 3
Olney, 3,765 . . . . . C 3
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Ozona, 2,885 . . . . . D 2
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Palestine, 12,503 . . . . . D 5
Pampa, 16,583 . . . . . B 2
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Phillips, 4,105 . . . . . B 2
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Rusk, 6,598 . . . . . D 5
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Sanatorium, 1,800 . . . . . D 2
San Augustine, 2,510 . . . . . D 5
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San Saba, 3,400 . . . . . D 3
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Santa Elena, 950 . . . . . F 3
San Ygnacio, 950 . . . . . F 3
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Seymour, 3,779 . . . . . C 3
Shafter, 1,736 . . . . . F 2
Shallowater, 2,000 . . . . . C 2
Shamrock, 3,322 . . . . . B 2
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Shiner, 1,778 . . . . . E 4
Sierra Blanca, 1,000 . . . . . F 1
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Taylor, 9,071 . . . . . D 4
Teague, 2,925 . . . . . D 4
Temple, 25,467 . . . . . D 4
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Terrell Hills, 2,708 . . . . . B 4
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Texas City, 16,620 . . . . . E 5, G 5
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Throckmorton, 1,320 . . . . . C 3
Timpson, 1,455 . . . . . D 5
Tivoli, 900 . . . . . E 4
Trinidad, 1,000 . . . . . C 4
Trinity, 2,054 . . . . . D 5
Troup, 1,539 . . . . . C 5
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Waelder, 1,275 . . . . . E 4
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Weimar, 1,663 . . . . . E 4
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Briscoe, 3,528 . . . . . B 2
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Garza, 6,281 . . . . . C 2
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Hartley, 1,913 . . . . . B 1
Haskell, 13,736 . . . . . C 3
Hays, 17,840 . . . . . D 3
Hemphill, 4,123 . . . . . B 2
Henderson, 23,405 . . . . . C 5
Hidalgo, 160,446 . . . . . F 3
Hill, 31,282 . . . . . D 4
Hockley, 20,407 . . . . . C 1
Hood, 5,287 . . . . . C 4
Hopkins, 23,490 . . . . . C 5
Houston, 22,825 . . . . . D 5
Howard, 26,722 . . . . . C 2
Hudspeth, 4,298 . . . . . F 1
Hunt, 42,731 . . . . . C 4
Hutchinson, 31,580 . . . . . B 2
Irion, 1,590 . . . . . D 2
Jack, 7,755 . . . . . C 3
Jackson, 12,916 . . . . . E 4
Jasper, 20,049 . . . . . D 6
Jeff Davis, 2,090 . . . . . F 2
Jefferson, 195,083 . . . . . E 5
Jim Hogg, 5,389 . . . . . F 3
Jim Wells, 27,991 . . . . . F 3
Johnson, 31,390 . . . . . C 4
Jones, 22,147 . . . . . C 3
Karnes, 17,139 . . . . . E 4
Kaufman, 31,170 . . . . . C 4
Kendall, 5,423 . . . . . E 3
Kenedy, 632 . . . . . F 4
Kent, 2,249 . . . . . C 2
Kerr, 14,022 . . . . . D 3
Kimble, 4,619 . . . . . D 3
King, 870 . . . . . C 2
Kinney, 2,668 . . . . . E 2
Kleberg, 21,991 . . . . . F 4
Knox, 10,082 . . . . . C 3
Lamar, 43,033 . . . . . C 5
Lamb, 20,015 . . . . . B 1
Lampasas, 9,929 . . . . . D 3
La Salle, 7,485 . . . . . E 3
Lavaca, 22,159 . . . . . E 4
Lee, 10,144 . . . . . D 4
Leon, 12,024 . . . . . D 5
Liberty, 26,729 . . . . . D 5
Limestone, 25,251 . . . . . D 4
Lipscomb, 3,658 . . . . . A 2
Live Oak, 9,054 . . . . . E 3
Llano, 5,377 . . . . . D 3
Loving, 227 . . . . . D 1
Lubbock, 101,048 . . . . . C 2
Lynn, 11,030 . . . . . C 2
McCulloch, 11,701 . . . . . D 3
McLennan, 130,194 . . . . . D 4
McMullen, 1,187 . . . . . E 3
Madison, 7,996 . . . . . D 5
Marion 10,172 . . . . . C 5
Martin, 5,541 . . . . . C 2
Mason, 4,945 . . . . . D 3
Matagorda, 20,559 . . . . . E 5
Maverick, 12,292 . . . . . E 2
Medina, 17,013 . . . . . E 3
Menard, 4,175 . . . . . D 3
Midland, 25,785 . . . . . D 1
Milam, 23,585 . . . . . D 4
Mills, 5,999 . . . . . D 3
Mitchell, 14,357 . . . . . C 2
Montague, 17,070 . . . . . C 4
Montgomery, 24,504 . . . . . D 5
Moore, 13,349 . . . . . B 2
Morris, 9,433 . . . . . C 5
Motley, 3,963 . . . . . B 2
Nacogdoches, 30,326 . . . . . D 5
Navarro, 39,916 . . . . . D 4
Newton 10,832 . . . . . D 6
Nolan, 19,808 . . . . . C 2
Nueces, 165,471 . . . . . F 4
Ochiltree, 6,024 . . . . . A 2
Oldham, 1,672 . . . . . B 1
Orange, 40,567 . . . . . D 6
Palo Pinto, 17,154 . . . . . C 3
Panola, 19,250 . . . . . C 5
Parker, 21,528 . . . . . C 4
Parmer, 5,787 . . . . . B 1
Pecos, 9,939 . . . . . D 1
Polk, 16,194 . . . . . D 5
Potter, 73,366 . . . . . B 2
Presidio, 7,354 . . . . . F 2
Rains, 4,266 . . . . . C 5
Randall, 13,774 . . . . . B 2
Reagan, 3,127 . . . . . D 2
Real, 2,479 . . . . . E 3
Red River, 21,851 . . . . . C 5
Reeves, 11,745 . . . . . D 1
Refugio, 10,113 . . . . . E 4
Roberts, 1,031 . . . . . B 2
Robertson, 19,908 . . . . . D 4
Rockwall, 6,156 . . . . . C 4
Runnels, 16,771 . . . . . D 3
Rusk, 42,348 . . . . . C 5
Sabine, 8,568 . . . . . D 6
San Augustine, 8,837 . . . . . D 5
San Jacinto, 7,172 . . . . . D 5
San Patricio, 35,842 . . . . . F 4
San Saba, 8,666 . . . . . D 3
Schleicher, 2,852 . . . . . D 2
Scurry, 22,779 . . . . . C 2
Shackelford, 5,001 . . . . . C 3
Shelby, 23,479 . . . . . D 5
Sherman, 2,443 . . . . . A 2
Smith, 74,701 . . . . . C 5
Somervell, 2,542 . . . . . C 4
Starr, 13,948 . . . . . F 3
Stephens, 10,597 . . . . . C 3
Sterling, 1,282 . . . . . D 2
Stonewall, 3,679 . . . . . C 2
Sutton, 3,746 . . . . . D 2
Swisher, 8,249 . . . . . B 2
Tarrant, 361,253 . . . . . C 4
Taylor, 63,370 . . . . . C 3
Terrell, 3,189 . . . . . D 1
Terry, 13,107 . . . . . C 1
Throckmorton, 3,618 . . . . . C 3
Titus, 17,302 . . . . . C 5
Tom Green, 58,929 . . . . . D 2
Travis, 160,980 . . . . . D 4
Trinity, 10,040 . . . . . D 5
Tyler, 11,292 . . . . . D 5
Upshur, 20,822 . . . . . C 5
Upton, 5,307 . . . . . D 2
Uvalde, 16,015 . . . . . E 3
Val Verde, 16,635 . . . . . E 2
Van Zandt, 22,593 . . . . . C 5
Victoria, 31,241 . . . . . E 4
Walker, 20,163 . . . . . D 5
Waller, 11,961 . . . . . E 4
Ward, 13,346 . . . . . D 1
Washington, 20,542 . . . . . D 4
Webb, 56,141 . . . . . F 3
Wharton, 36,077 . . . . . E 4
Wheeler, 10,317 . . . . . B 2
Wichita, 98,493 . . . . . B 3
Wilbarger, 20,552 . . . . . B 3
Willacy, 20,920 . . . . . F 4
Williamson, 38,853 . . . . . D 4
Wilson, 14,672 . . . . . E 3
Winkler, 10,064 . . . . . D 1
Wise, 16,141 . . . . . C 4
Wood, 21,308 . . . . . C 5
Yoakum, 4,339 . . . . . C 1
Young, 16,810 . . . . . C 3
Zapata, 4,405 . . . . . F 3
Zavala, 11,201 . . . . . E 3

COURTESY OF THE HOUSTON CHAMBER OF COMMERCE

*VIEW OF HOUSTON, THE LARGEST CITY IN TEXAS AND A MAJOR SHIPPING CENTER*

LEADING TEXAS INDUSTRIES
(1947)

| | *Avg. No. of Persons Employed* | *Value Added by Manufacture ($1,000)* |
|---|---|---|
| Petroleum and coal products | 37,696 | 359,680 |
| Food and kindred products | 57,784 | 337,558 |
| Chemicals and allied products | 23,552 | 234,496 |
| Machinery, except electrical | 23,299 | 129,575 |
| Lumber and products, except furniture | 30,694 | 95,988 |
| Printing and publishing | 17,756 | 92,467 |
| Transportation equipment | 20,735 | 91,893 |
| Apparel and related products | 22,008 | 71,128 |

Other manufactures in Texas are fabricated metal products, primary metal processing, paper and allied products, lumber and fixtures, textile mill products, leather and leather products, stone, clay, and glass products, and electrical machinery.

**Transportation.** The wide area of Texas and the lack of navigable rivers have, from the beginning, confronted its people with problems of transportation and distribution. The first railroad began operation in 1853, but it was not until 1873 that the isolated Texas railway system was connected with that of the other states. In 1950, there were 15,559 mi. of main-line track in Texas. This made Texas the leading state in main-line mileage. There is constant traffic movement in the thirteen Texas deepwater ports, notably those of Houston, Galveston, Texas City, Beaumont, Port Arthur, and Corpus Christi.

Much of the transportation in Texas is carried on by highway. In 1950 the Texas Highway Department had control over 34,929 mi. of highway. In addition there were 164,707 mi. of roads subject to county control. More than 60,000 mi. of the country roads in Texas were classed as unimproved. Texas highways are financed by 75 per cent of the proceeds of a 4-cent gasoline tax, license fees, and Federal grants. In 1952 there were no toll roads that were under control of the Highway Department.

Warm climate and open terrain have favored aviation in Texas, and the Federal Government in World War I and World War II centered much of its military aviation training there. In 1951 eleven commercial airlines were operating in Texas.

## GOVERNMENT AND POLITICS

**Government.** The Texas state government is characterized primarily by the large powers given to the legislative branch, by a large and loosely integrated administrative system, and by a judiciary elected by popular vote. The state constitution is a document of 35,000 words and is characterized by a great amount of detail of statutory level. From its adoption in 1876 through 1952, the constitution has been amended more than 100 times. Peculiar features are its detailed bill of rights, its community-property provision giving husband and wife equal title in jointly acquired property, and its restriction on the placing of encumbrance upon a homestead. The constitution is similar to those of other states, but some of its provisions dealing with the public domain and with property rights were derived from Spanish law.

The administrative system is headed by the governor, who is assisted in his executive duties by a lieutenant governor, attorney general, comptroller of public accounts, treasurer, superintendent of public instruction, commissioner of agriculture, and commissioner of the General Land Office, all of whom are elected by popular vote for two-year terms. In addition there is the three-member Railroad Commission, which has jurisdiction over all transportation and oil and gas laws and is elected to six-year, overlapping terms. There were 130 operative officials, boards, and commissions as of Dec. 31, 1946. Most of the nonelective officials are appointed by the governor, in some instances with the advice and consent of the Senate and in some instances without such advice and consent. In 1952 the governor of Texas was Allan Shivers, Democrat.

The legislature consists of a House of Representatives of 150 members and a Senate of 31 members. It meets biennially the second Tuesday in January of odd-numbered years, and is limited to 120 days in regular session, with privilege of ex-

COURTESY OF THE AUSTIN CHAMBER OF COMMERCE

*AIR VIEW OF AUSTIN, CAPITAL CITY OF TEXAS. THE INSET SHOWS THE STATE CAPITOL.*

*Looking down on North St. Paul Street, Dallas. The eleventh district Federal Reserve Bank and one of the nation's most important cotton exchanges are located in this city.*

EWING GALLOWAY

tending the session indefinitely but with a pay cut from $10 to $5 a day. The governor may call extraordinary sessions of the legislature.

The judiciary is headed by a supreme court of nine members and a court of criminal appeals of three members, with an assisting commission of two members. The supreme court has final jurisdiction in civil cases and the court of criminal appeals has final jurisdiction in criminal cases. There are eleven courts of civil appeals in the state. These courts have jurisdiction, respectively, over the eleven districts into which the state is divided. The district court is the chief trial court. There are also a number of county courts and justice of the peace courts.

Texas has twenty-two representatives and two senators in the United States Congress. In 1953 the United States Senators from Texas were Lyndon B. Johnson and Price Daniel, both Democrats.

**State Finance.** During the fiscal year which ended Aug. 31, 1952, the Texas government had an income of $819,388,306.02. This total included $130,064,695.99 listed as "Non-Revenue Receipts." The largest items of state income included $155,985,609.28 from gross receipts and production taxes; $104,734,439.45 from the gasoline tax; $34,888,669.93 from the cigarette tax; $35,406,899.30 from automobile license fees; $24,256,967.15 from the ad valorem tax; $43,355,491.08 from land sales, rentals, and royalties; and $148,357,538.10 in county, Federal, and other aid.

During the same year total governmental cost was listed as $617,210,759.40, and there were in addition "Non-Cost" payments of $154,909,272.49. The chief items of governmental expenditure were: highways, $137,718,848.77; public schools, $200,254,107.02; public welfare, $120,053,141.73; and higher education, $41,861,548.59.

**Banks.** On Dec. 30, 1950, there were 442 national banks and 449 state banks operating in Texas. The national banks had resources of $6,467,275,000 and the state banks had resources of $1,427,679,000.

**Political Movements.** The dominant Democratic party has won all state elections from the beginning of statehood in 1845 through 1952 with the exception of the elections of the Reconstruction period, when suffrage was restricted, and the election of 1859, when the Know-Nothing party won with the aid of insurgent Democrats. The state has voted Democratic in presidential elections with the exceptions of 1928 and 1952. In 1928 the electoral vote of the state was cast for Herbert Hoover and in 1952 it was cast for Dwight D. Eisenhower.

**Military Activities.** The Texas state military activities are directed by the adjutant general, appointed by the governor. The Texas State National Guard had reassigned to it, after World War II, its historic Thirty-Sixth Division and, in addition, an armored division.

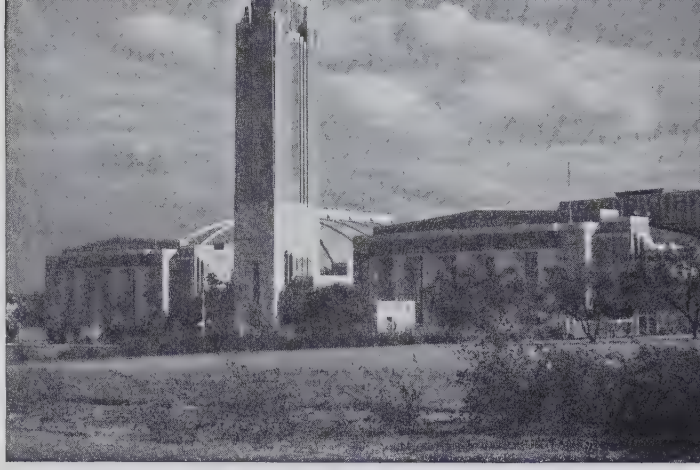
## SOCIAL AND CULTURAL INSTITUTIONS

Influencing factors in the educational and social conditions of Texas have been the wide dispersal of population over a great area, the relatively large rural population, the rapid economic development of the state, the great variation in local financial ability to support schools, and the appreciable population of substandard income groups in some areas, including Latin Americans along the border, the Negro population of east and central Texas, and the sharecropper tenants, both white and Negro, of the east, central, and south Texas cotton-growing areas.

**Education.** The state system of public education is headed by a state Commissioner of Education appointed by a Board of Education, consisting of twenty-one members. Education is compulsory in Texas for all children from seven to sixteen years of age inclusive; whites and Negroes are segregated in separate schools. In 1949-1950 there were approximately 2,500 school districts in Texas. Most of these were common, or rural, districts, but about 1,000 of them were independent districts. During that year the scholastic population was 1,557,798 and the average daily attendance was 1,151,960. The system employed more than 54,000 teachers in 1949-1950, and these received an average salary of $3,183.

An important factor in the early development of education in Texas was the allocation of large quantities of the public domain to the schools. Under the agreement by which Texas was annexed to the Union, the state retained all of its public domain, amounting at that time to considerably more than one half the area of the state. During the period of Republic and early statehood, a total of 49,518,332 acres were put aside for the benefit of common schools and higher education.

The state's largest institution of higher education is the University of Texas, at Austin. Other leading state educational institutions are the Agricultural and Mechanical College of Texas, at College Station; Texas Technological College, at Lubbock; Texas State College for Women, at Denton, and nine other senior state colleges. Until 1946, the principal higher educational institution for Negroes was the Prairie View Normal College at Prairie View. The Fiftieth Legislature (1947) established the Texas State University for Negroes at Houston, and converted Prairie View Normal College into an agricultural and mechanical college for Negroes. Principal church and private educational institutions of Texas include Rice Institute, at Houston; Baylor



CHARLES PHELPS CUSHING

*THE WILL ROGERS MEMORIAL, FORT WORTH, TEXAS*

University, at Waco; Southern Methodist University, at Dallas; Texas Christian University, at Fort Worth; and St. Mary's University and Our Lady of the Lake College, at San Antonio.

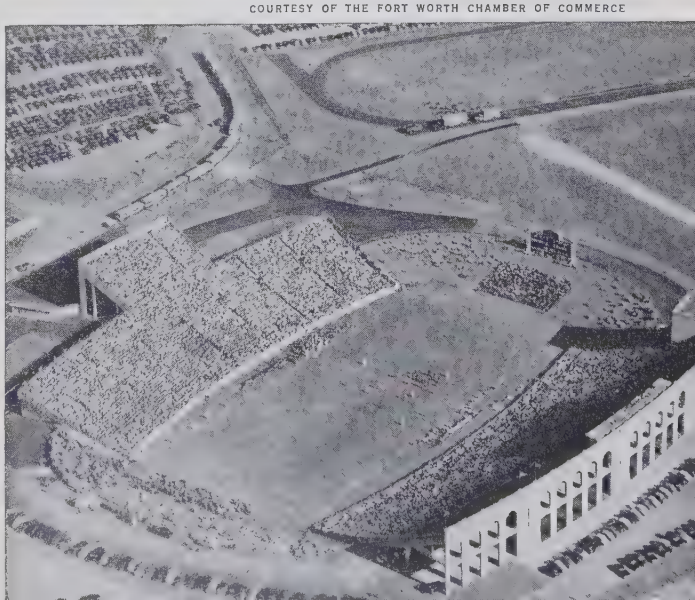
**Social Measures.** The state public welfare program is administered by the Department of Public Welfare. Funds used by this department are received in part from the state and in part from the national government. In May 1950, a total of 225,187 persons received pensions averaging $33.63. In the same month, payments were made to 53,608 dependent children in 19,123 families. The payments averaged $24.68 per family. Payments are also made to the needy blind, to Confederate veterans, and to the widows of Confederate veterans. The state maintains a number of eleemosynary institutions and grants assistance to about 300 Alabama and Coushatta Indians who live on a small reservation in Polk County. The prison system consists of the main plant at Huntsville and eleven prison farms.

**Cultural Activities.** The largest library is that of the University of Texas with over 1,000,000 volumes, notable for its special libraries, including the Latin American collection, the Wrenn Library of first editions, the Southern Collection, the Texas Collection, and the Stark Collection. Many historic documents are found also in the Texas State Library, which contains 225,000 volumes. The Browning Collection of Baylor University, Waco, is also notable. The state's principal museum is the Texas Memorial Museum at the University of Texas, Austin.

There are three major symphony orchestras in Texas: the Houston, the Dallas, and the San Antonio. In addition to

*STADIUM OF TEXAS CHRISTIAN UNIVERSITY, FORT WORTH*

COURTESY OF THE FORT WORTH CHAMBER OF COMMERCE



EWING GALLOWAY

*Centuries of erosion have produced these strange rock towers in Palo Duro Canyon State Park.*

giving an annual series of concerts, these organizations sponsor various activities, such as the commissioning of contemporary composers, the awarding of prizes for compositions of resident Texas composers, and the presentation of productions of grand opera.

The Fort Worth Civic Opera utilizes resident talent, importing well-known stars only if they are needed for particular productions.

The Little Theatre in Dallas is an outstanding nonprofessional group, and little-theatre groups are also found in Houston, Austin, and at the University of Texas, at Baylor University, at Southern Methodist University, and at other educational institutions.

## POPULATION

**General Statistics.** The Census of 1950 gave Texas a population of 7,711,194, or 28.8 per sq. mi. This was an increase of 20.2 per cent over the population of 1940. Texas ranked sixth among the states in population in 1950. In that year, 62.7 per cent of her people were classed as urban and 37.3 were classed as rural. A century earlier 96.4 per cent of the people had been classed as rural and only 3.6 per cent as urban.

**Ethnic Groups.** The Census of 1950 classes 88.5 per cent of the people of Texas as white and 11.5 as nonwhite. Most of the white population is of Anglo-American origin. There are, however, a large number of Latin Americans and numerous citizens of German, Italian, or Czech origin. Aside from many of the Latin Americans, there are very few Texans who can be classed as foreign born.

**Labor Statistics.** There were 5,600,000 persons 14 years of age and older in 1950. The total labor force numbered 3,006,000 (2,264,000 male and 742,000 female). The civilian labor force numbered 2,935,000, of whom 95,000 were listed as unemployed.

**Religion.** Most Texans who are church members belong to Protestant organizations. The Baptist, Methodist, and Presbyterian churches are the largest of the Protestant groups. There are also many Catholics in Texas, especially in the counties bordering Mexico.

## RECREATIONAL ASSETS AND HISTORIC SITES

Principal recreational regions are: (1) the Trans-Pecos Mountains; (2) the Edwards Plateau with its innumerable spring-fed streams; (3) the beaches of the Gulf Coast; and (4) the east Texas forest area. The Big Bend National Park, of 708,221 acres, was established in 1944 and, after a wartime delay, was under development in 1946. There are four national forests—Sam Houston, Davy Crockett, Angelina, and Sabine—totaling 661,700 acres in east Texas; these national forests have been set aside for both timber conservation and popular recreation. Under administration of the Texas State Parks Board are thirty-six developed parks, of which the Palo Duro Canyon State Park, of 15,103 acres, is the most extensive.

Notable points of historic interest are the Alamo, at San Antonio, "Cradle of Texas Liberty," and the San Jacinto Battlefield Monument near Houston, a 570-foot shaft. Most notable of Texas public buildings is the state capitol, which was built of pink granite that had been quarried near Austin; this building was one of the world's largest capitols at the time of its completion in 1888.

## HISTORY

**Exploration.** The first written record of the landing of the white man in Texas is that of the Pánfilo de Narváez expedition, which was shipwrecked in the vicinity of present Galveston Island in 1528, though it is probable that the expedition of Alvarez de Piñeda, skirting the gulf coast in 1519, made temporary landings. There followed the period of the conquistadores and the search for the Seven Cities of Cibola, during which Francisco Vásques de Coronado, Hernando de Soto, Antonio de Espejo, and other explorers crossed portions of the state. Other than searching for treasure, however, the Spanish gave little attention to establishing their sovereignty until the expedition of Robert Cavelier de La Salle in 1685 aroused suspicions of French designs. Beginning in 1689, a series of Spanish missions was established, and the Spanish effort continued intermittently until the secularization of the missions in 1793. The period, however, left a colony of only about 7,000 white persons, largely in the vicinity of San Antonio. The aboriginal Indian population of the state consisted of the crop-growing Caddo tribes, who lived on the rivers of the eastern area; the fierce, roving Comanches and the Lipan Apaches, who ranged over the western part of the state; and a number of fish-economy tribes, who had settled along the coast.

**Political Development.** Interest in Anglo-American colonization began with the petition of Moses Austin of Missouri to the Spanish government in 1820. His death that year left fulfillment of his responsibilities to his son, Stephen F. Austin, who, in 1821, renegotiated the agreement with the new independent Mexican government and established a colony on the Lower Brazos, which was followed by a number of other colonial enterprises which swelled the population of Texas to more than 20,000.

There was soon conflict, however, between the Anglo-American colonists and the Mexican authorities over the establishment of free schools, the levying of imposts by Mexico, and the maintenance of constitutional government. This culminated in the Texas revolution of 1835-1836, during

which the dictator, General Lopez de Santa Anna, was defeated at the Battle of San Jacinto, on Apr. 21, 1836, near present Houston, by the Texan army under General Sam Houston. Texas' independence was declared in a convention at Washington-on-the-Brazos, on Mar. 2, 1836, but was followed shortly thereafter by the tragic defeat and destruction of a small Texan force under Colonel William Barrett Travis by Santa Anna's forces at the Alamo, San Antonio, on March 6. The victory at San Jacinto was celebrated by the establishment of the Republic of Texas, which lasted from 1836 through 1845 and received the recognition of the United States, Great Britain, France, and some of the German states, though Mexico never relinquished its claim. The presidents of the Republic in succession were: David Burnet, provisional; Sam Houston; Mirabeau B. Lamar; Houston (second term); and Anson Jones. The period of the Republic was beset primarily by financial difficulties, the constant threat of invasion by Mexico, and a continuing struggle with the Indians.

The annexation of Texas to the United States as the twenty-eighth state, on Dec. 29, 1845, precipitated the Mexican War, which was ended by the Treaty of Guadalupe Hidalgo. By the terms of this treaty, Mexico relinquished its claim to Texas and also ceded New Mexico and California to the United States.

**Civil War Period.** Though Texas seceded to join the Southern Confederacy it saw little of military action except the capture and recapture of Galveston Island, the unsuccessful attack of United States troops on Sabine Pass, and two clashes in the Rio Grande Valley, where Federal attention had been drawn to Confederate cotton exports by blockade running. From the end of the war until Mar. 30, 1870, the date of readmission, Texas was under the administration of the Reconstruction governors, during which secessionist elements were barred from voting by the "ironclad oath." In the election of 1873, however, Richard Coke defeated the incumbent, E. J. Davis. Davis then attempted to have the election declared void, and for a few days the state capitol at Austin sheltered the armed camps of the two contenders. President Ulysses S. Grant refused to sustain Governor Davis, however, and the Reconstruction, or "carpetbag," rule was thus ended.

**Economic Development.** The subsequent history of Texas has been characterized primarily by economic rather than political and military developments. Railroad construction boomed during the seventies, eighties, and nineties, and the western area changed from the open range to the livestock range, while the farmer followed the cowman in the western advance. Momentous was the discovery of the first big oil field, Spindletop, near Beaumont, in 1901, inaugurating what might be called the oil era of Texas economy. The first two decades of the twentieth century were characterized by the rapid development of the High Plains and the Corpus Christi and Rio Grande Valley territories and the rapid commercial and industrial expansion which built the cities of Houston, Dallas, San Antonio, and Fort Worth and brought the excavation of the deepwater ports along the coast. Because of the basic nature of its frontier economy, the state suffered somewhat less during the economic depression of 1929-1934 than the more industrial areas of the country, and it revived even before the boom in war industries began in 1941.

**Political Controversy.** The first noteworthy political event of the post-Civil War period was the administration of Governor James Stephen Hogg, 1891-1895, which enacted railroad control legislation, including the establishment of the State Railroad Commission in 1891, the ouster of a large oil corporation and considerable legislation directed at outside monopoly control of Texas oil and other resources. In 1915 Governor James E. Ferguson was elected, but he was ousted in 1917 by impeachment. This began a long controversy over "Fergusonism," during which the ousted governor's wife was twice elected chief executive, in 1925-1927 and 1933-1935. Great political excitement was also aroused during the campaigns involving W. Lee O'Daniel and in the 1946 campaign, in which the candidates were Homer P. Rainey and Beauford Jester.

*OIL WELLS NEAR BEAUMONT, AN OIL-REFINING CENTER AND OIL PORT*

EWING GALLOWAY

**Military Participation.** Texas contributed notable military service in both World War I and World War II through its man power and the large number of aviation, ground

force, and navy training installations maintained in the state. In both wars the Thirty-Sixth Division (Texas National Guard) was mobilized in its home state. During World War I, Texas contributed nearly 210,000 men to the armed forces; during World War II, the state contributed 585,000 men and 9,704 women to the army, and 196,118 men and 3,150 women to the Navy. S. McG. and R. W. S.

**TEXAS, AGRICULTURAL AND MECHANICAL COLLEGE OF,** an accredited, state-controlled, and state-supported university for men, at College Station, Tex. The total university grounds include more than 8,300 acres, including branches at Stephenville and Arlington. The school is a land-grant college and was originally founded in 1862 under the provisions of the Morrill Act. Students were admitted in 1876.

The divisions of the university include agriculture, engineering, veterinary medicine, arts and sciences, graduate school, experiment stations, and forestry service. These branches offer the A.B. in arts and sciences; the B.S. in business, various engineering curricula, and agriculture; the D.V.M. (veterinary medicine); and the Ph.D. Courses in food technology and flight training have been recent additions. Courses in military science are required, and Army R.O.T.C. units provide this training. Dormitories and dining halls are available and there are no fraternities on the campus. Scholarship assistance is generous and a large fund has been established for loans to students. *For statistics see* Colleges and Universities. J. R. To.

**TEXAS, UNIVERSITY OF,** an accredited, coeducational, state-controlled institution occupying approximately 1,100 acres. The main campus is located at Austin, Tex., the Medical Branch at Galveston, the Dental Branch and the M. D. Anderson Hospital for Cancer Research at Houston, and the College of Mines and Metallurgy at El Paso. Cooperating with the Medical Branch are the Sealy and Smith Foundation, the John Sealy Hospital, the State Hospital for Crippled and Deformed Children, and the Galveston State Psychopathic Hospital. The university was organized by legislative act in 1881 and first instruction was offered in 1883, when the College of Arts and Sciences and the School of Law opened in Austin. The other divisions were founded as follows: School of Medicine, 1891; College of Pharmacy, 1893 (moved to main university at Austin, 1927); College of Engineering, 1894; College of Nursing, 1897; School of Education, 1906; Division of Extension, 1909; Graduate School, 1910; College of Business Administration, 1922; College of Fine Arts, 1938; Dental Branch, 1943; and School of Architecture (within the College of Engineering), 1948. The College of Mines and Metallurgy was made a branch of the university in 1919 by legislative act but has its own president and administrative officers.

The degrees offered include the A.B.; the B.S. in education, elementary education, and physical education, architectural, chemical, civil, electrical, and mechanical engineering, geology, home economics, medicine, nursing, and pharmacy; the B.J.; the B.Arch.; the B.B.A.; the LL.B.; the M.B.A.; the M.J.; the M.Ed.; the M.S.; the Ed.D.; the M.D.; and the Ph.D. Training for the armed forces is under the direction of the Navy R.O.T.C. and Army R.O.T.C. The local chapter of Phi Beta Kappa was founded at the University of Texas in 1905.

The university is one of four southern universities receiving the Carnegie Corporation grant for the five-year experimental program to develop permanent university centers for Latin American studies. Baylor, Rice, and the University of Houston are co-operating with Texas University in the establishment of the new Texas Medical Center at Houston. Extensive library facilities are available in the main library on the Austin campus and in the separate libraries operated for the various divisions. Featured are the Bieber collection of American poetry, the Texas collection, the Latin American collection, the archives collection, material on Southern history, and the Abraham I. Schechter collection of Hebraica and Judaica.

Scholarships offered include one to each accredited secondary school in Texas. There is a loan fund. Employment opportunities enable more than half of the students to earn part of their expenses. The sororities and fraternities also provide additional living accommodations. *For statistics see* Colleges and Universities. J. R. To.

**TEXAS CHRISTIAN UNIVERSITY,** an accredited, privately controlled coeducational institution, affiliated with the Disciples of Christ Church. The buildings and grounds occupy approximately 150 acres at Fort Worth, Tex. Five miles from the main campus is the affiliated Harris College of Nursing. The institution was founded in 1873 by Addison and Randolph Clark at Thorp Springs, Tex., under the name of Add-Ran Christian University. The charter was granted the following year. In 1895 the university moved to Waco, where it remained until the Fort Worth site was established in 1910. The name was changed to the present form in 1902.

Divisions include liberal arts, nursing, fine arts, education, business, evening college, graduate school, and the Brite College of the Bible. Special programs are given in engineering, home economics, and journalism. The degrees offered include the A.B., the B.S., the B.F.A., the B.D., the B.C.S., the M.S., and the M.A.

Undergraduate students from out of the city who are under 21 years of age must live in the university residence halls unless special permission for other arrangements is obtained. Graduate fellowship and undergraduate scholarship aid is generous, and there are opportunities for self-help. There are also some scholarships and fellowships covering tuition, fees, books, and so forth, which are administered specifically for foreign students in the university. *For statistics see* Colleges and Universities. J. R. To.

**TEXAS CITY,** an industrial city in southeastern Texas, in Galveston Co., situated on a channel to Galveston Bay, 30 mi. southeast of Houston. Located in a large natural-gas field, the city is largely industrial and has a land-locked inner deep-water harbor 875 to 1,100 ft. wide and 5,300 ft. long. Texas City was founded in 1821 by Jim Campbell, one of the retired lieutenants of the pirate Jean Lafitte. In 1892 a group of shipping men from the Great Lakes area arrived at the site and soon began developing the city and port. Texas City was incorporated in 1911 and has the commission form of government. In April 1947 the city was almost totally destroyed by fires which raged for three days. The fires were started on April 16 by an explosion on the freighter *Grandcamp,* containing ammonium nitrate, docked in the harbor. The fire spread to docks, oil tanks, and the Monsanto Chemical Company plant, which set off chains of fires and explosions throughout the area. On April 17 another freighter, *High Flyer,* also loaded with ammonium nitrate, exploded and the city was declared in a state of emergency. The fires were extinguished finally on the next day, with the result of an estimated property loss of $50,000,000, 512 known

dead, 3,000 injured, and approximately 300 missing. One year later, on April 16, 1948, with a single exception, the city's industrial plants were back in operation and the production figures were equal to or greater than those at the time of the tragedy. Manufactures include tin smelting, petroleum refining, and the production of chemicals. As a port, Texas City ships ore, tin, oil, potash, wool, grain, chemicals, and food products. Transportation is supplied by the Burlington-Rock Island, the Missouri-Kansas-Texas, the Missouri Pacific, the Santa Fe, the Southern Pacific, and the Texas City Terminal railroads. Pop. 1950, 16,620.

*Texas City under dense smoke from the blasts and fires caused by explosions of ammonium nitrate on a freighter in the harbor on April 16, 1947*

SOUTHERN NEWSPIX

**TEXAS COLLEGE OF ARTS AND INDUSTRIES,** an accredited, coeducational, state-controlled technological institution located on 451 acres in Kingsville, Tex. It was chartered as South Texas State Teachers College in 1917 and first instruction was offered in 1925. The name was changed to the present form with the granting of a new charter in 1929. The Industrial Arts Department was established in 1946. The Agriculture Department was expanded through the acquisition in 1947 of a lease on the 2,850-acre Kingsville Naval Auxiliary Air Station. The training center for citrus and vegetable courses is situated in the Rio Grande Valley, 106 mi. from the campus. The degrees offered include the A.B. and the B.S. in liberal arts; the B.S. in agriculture, home economics, elementary education, and secondary education; the B.B.A.; the B.Mus.; the M.S.; and the M.A. The B.S. is also offered in general, chemical, electrical, mechanical, and natural-gas engineering. Residence halls are maintained for students who do not commute. Some scholarship and loan assistance is available. *For statistics see* COLLEGES AND UNIVERSITIES. J. R. To.

**TEXAS FLY** or **TEXAS FRUIT FLY,** the common name of *Anastrepha ludens,* one of the fruit flies of the family Trupaneidae, or Trypetidae. This fly has long been a serious pest of citrus fruits in southern Texas. Great progress has been made in reducing the losses resulting from damage to fruit by the larvae, which somewhat resemble the maggots of the housefly. Many kinds of tropical and subtropical fruits are attacked by the Texas fly in Central America. *See also* FRUIT FLY. C. H. Cu.

**TEXAS STATE COLLEGE, NORTH,** an accredited, coeducational, state-controlled, and state-supported institution located on 150 acres in Denton, Tex. It was chartered as Texas Normal College in 1890, when first instruction was granted. It was made a state college and the name was changed to North Texas Normal College in 1901. The change to North Texas State Teachers College was made in 1923, and to the present in 1949. The Graduate Division was added in 1935. Under a recent reorganization the following divisions were set up: the College of Arts and Sciences and the schools of Business Administration, Education, Home Economics, and Music. A permanent program in health education with a full-time director has been added. Special courses are given in the training of teachers of handicapped children. Degrees offered include the A.B., the B.S., the B.B.A., the B.Mus., the B.S. in library service and home economics, the M.S., the M.Mus., the M.B.A., and the M.A. The library includes special collections on Latin America, children's literature, and rare Texas historical items. Scholarship aid is limited to small grants to high-school valedictorians. Dormitories and dining halls are available. *For statistics see* COLLEGES AND UNIVERSITIES. J. R. To.

**TEXAS STATE COLLEGE, WEST,** an accredited, coeducational, state-controlled, and state-supported teacher-training institution and school of liberal arts and business administration. It is located in Canyon, Tex., on a campus of 272 acres. The charter was originally granted to West Texas State Normal College in 1909 and first instruction was given in 1910. The name was changed to West Texas State Teachers College in 1923, and to the present in 1949. The four-year courses leading to the A.B. and the B.S. degrees were introduced in 1917. Courses leading to the M.A. were first offered in 1932, and in 1937 a curriculum was established leading to the M.B.A. The vocational and trade school was opened in 1947. Degrees offered include the A.B., the B.S., the B.B.A., the B.S. in education, the M.B.A., and the

M.A. Scholarships remitting the fees of the freshman year are available to high-school honor graduates. Additional financial aid is available in special cases. Dormitories and dining halls and some housing for married couples are provided. *For statistics see* COLLEGES AND UNIVERSITIES.

J. R. To.

**TEXAS STATE COLLEGE FOR WOMEN,** a state-controlled, accredited college of arts and sciences, occupying a 172-acre campus in Denton, Tex. It was founded in 1901 and first instruction was offered in 1903. The degrees offered include the A.B. and the B.S. in liberal arts; the A.B. and the B.S. in business administration; the B.S. in library science; and the M.A. Among the many departments in which majors may be taken are biology, chemistry, English, fine and applied arts, health and physical education, home economics, music, education, and speech. All students are required to reside in the dormitories or in approved student houses. Tuition scholarships are offered to high-school valedictorians of the state, and there is a student loan fund. Financial help in the way of campus jobs and assistantships is available to a substantial number of students. *For statistics see* COLLEGES AND UNIVERSITIES. J. R. To.

**TEXAS STATE TEACHERS COLLEGE, EAST,** an accredited, coeducational, state-controlled, and state-supported institution located on a 210-acre campus in Commerce, Tex. Established in 1894 as East Texas Normal College, it became a state institution in 1917. The name was changed to the present form in 1923. Degrees offered include the A.B., the B.S., the B.B.A., the B.Mus.Ed., the M.S., and the M.A. Majors and minors may be chosen in art, science, English, history, home economics, industrial education, library science, music, and physical education. Scholarship aid is limited, but there are some opportunities for students to earn part of their expenses. There is a student loan fund. Student housing must be approved by the deans of men and women. Dormitory facilities are limited in capacity. *For statistics see* COLLEGES AND UNIVERSITIES. J. R. To.

**TEXAS STATE TEACHERS COLLEGE, SOUTHWEST,** an accredited, coeducational, state-controlled teacher-training institution occupying 76 acres in San Marcos, Tex., about 30 mi. south of Austin. It was established in 1899 as Southwest Texas State Normal School. First instruction was given in 1903, and the four-year course leading to the bachelor's degree was offered in 1918. The name was changed to the present form in 1923. Graduate work leading to the master's degree was added in 1936. Courses in special education for handicapped children were introduced in 1945. The degrees offered include the A.B., the B.S., the B.B.A., the B.Mus., and the M.A. Scholarship aid in the form of a remission of freshman fees is offered to the honor graduates of the high schools in Texas. Opportunities for self-help enable a limited number of students to earn part of their expenses. All students must live in college dormitories, cooperative houses, or approved student homes. *For statistics see* COLLEGES AND UNIVERSITIES. J. R. To.

**TEXAS TECHNOLOGICAL COLLEGE,** an accredited, coeducational, state-controlled institution, offering courses in technology and in the arts and sciences. Established by legislative enactment in 1923, it occupies a campus of over 2,000 acres in Lubbock, Tex. First instruction was offered in 1925. The undergraduate divisions of agriculture, arts and sciences, business administration, engineering, and home economics date from the foundation of the college. The Graduate Division was established in 1936. Degrees offered include the A.B., the B.B.A., the B.S. in agriculture, home economics, education, and various engineering programs. Graduate degrees of M.B.A. and M.A. are offered. Training for the armed forces is under the direction of the Army R.O.T.C. Scholarships and student loans are available and there are opportunities for earning part of the expense of the college course. Dormitories are available for men and women. Other living quarters must be approved by the college. *For statistics see* COLLEGES AND UNIVERSITIES.

J. R. To.

**TEXCOCO** [tesko'ko], the largest of the five shallow lakes, irregular in shape and without drainage to the sea, which formerly occupied the Valley of Mexico in central Mexico. The Aztec capital, Tenochtitlán, now the site of Mexico City, was built on a system of islands and piles in the lake and connected with the mainland by three causeways, 2 to 5 mi. long. Drainage of the lake, begun by the Spaniards in 1607 and 1608, was completed in the twentieth century, leaving a small marshy area northeast of Mexico City's airport. The maximum depth of the lake was about 7 ft. Elaborate reclamation projects have been undertaken to wash the salts from the old lake bed soils. P. E. J.

**TEXEL** [tɛ'ksəl], largest, westernmost, and southernmost of the West Frisian Islands, lying off the northern coast of the Netherlands. It is 13 mi. long, 6 mi. broad, and 73 sq. mi. in area, and is separated from the mainland (province of North Holland) by the Mars Diep Strait, 1.5 mi. wide. The western part consists of dunes, the eastern of fertile cropland and excellent pasturage for about 35,000 sheep. Steamers from Den Helder on the far northern point of North Holland to Oudeschild on the southeast coast of Texel connect the island with the mainland. De Mok, a naval seaplane station, is at the south end on the inner side. The chief town is Texel (Den Burg op Texel), which has a sixteenth-century church. Koog is a west-coast fishing village and beach resort. Pop. 1952, 10,054.

S. Van V.

**TEXTILE FABRICS.** Textiles are lengths of woven or knitted cloth made of pliable fibers that have been spun into yarns. Textile fabrics are the most commonly used materials for clothing and many household uses. They date from prehistoric times.

**Types of Fibers.** Fibers may be either natural or synthetic, derived from animal, vegetable, or mineral sources. Common properties are strength, pliability, porosity, and adaptability to cleaning and to dyeing and other finishing. Animal fibers, protein in content, include wool, mohair, camel's hair, llama, alpaca, cashmere, vicuña, and silk, the last a product of the silkworm. Rabbit, beaver, and other fur fibers are used for felt, and sometimes combined with other fibers for apparel use. The vegetable fibers include cellulose, cotton, flax, ramie, and jute. Fibers such as hemp, raffia, and wheat are frequently utilized in the making of millinery braids or accessories, but are not considered textile fibers. Mineral fibers, until World War II not widely used for apparel, include asbestos and glass, both valuable because of their fire-resistant qualities. Asbestos, also highly absorbent, is combined with cotton for towels. Glass fibers in curtains and upholstery are used in theatres to reduce the fire hazard. Manufacturers give synthetic fibers various trade names that have no relation to the chemical or physical properties. Rayon is a generic term for synthetic fibers of cellulose or cellulose acetate content. Nylon is a class of synthetic fiber derived from coal products.

**Manufacturing Processes.** The essential processes involved in the manufacture of cloth have remained unchanged throughout history. With the exception of rayon and other synthetic yarns, the principal textile fibers, wool, flax, cotton, and silk, were familiar to ancient peoples. Fragments of wool unearthed from Swiss caves have been identified as dating from 15,000 B.C. Sheer hand-woven linens used for mummy wrappings in ancient Egypt are displayed at the Metropolitan Museum of Art in New York City in a remarkable state of preservation.

*Yarn.* Textile fibers, too short or fragile in themselves, are strengthened by spinning, which twists and binds them together. Still greater strength is imparted by throwing or further twisting the yarns together in preparation for cloth-making.

*Fabrics.* The steps followed in making cloth and other finished textiles are similar, regardless of the kind of fibers used. There are four basic methods: weaving, lacemaking, braiding, and rolling.

Cloth. Woven cloth, the commonest fabric, is made from a series of parallel yarns called warp through which another yarn—the filling, weft or woof—is interwoven. The warp yarns are set up in a loom consisting of a frame holding the heddles, wire strips with eyes for holding the yarns; a warp beam; and the cloth beam. In order to provide sufficient strength for the warp yarns, a gumlike sizing is applied. Then the warp yarns are threaded through the small heddles arranged lengthwise in the loom frame. The heddles raise and lower the desired warp yarns, making a shed through which the filling yarn is run. The shuttle, carrying the filling, interweaves it with the warp. Automatic looms throw the shuttle back and forth across the warp yarns with the heddles changing the arrangement of the yarns at high speed. Stronger yarns along the outer edge form the selvedge. The woven cloth is wound on the cloth beam at the opposite end of the loom.

Woven cloth can be distinguished from other fabrics in that it consists of yarns placed at right angles to each other. The quality of woven cloth is indicated by the "count," meaning the number of warp and filling yarns per square inch; the kind, size, and quality of the yarns; and the particular finishing method used. Narrow woven goods is used as ribbon or for the millinery trade; cloth exceeding 18 in. in width is known as broad silk or broad goods.

A new fabric is created when mill executives determine specifications, kind of fibers, count, weight, size of warp and filling, width, finishing, and approximate cost. Until the invention of artificial silk in 1885 by Hilaire de Chardonnet, cloth was made of wool, silk, linen, or cotton. Low-priced cloth combined wool and cotton or silk and cotton. While natural fibers make excellent fabrics, the high cost and other limitations exclude their use by many consumers. New fabrics combine the advantages of two or more fibers to effect a stronger or more desirable cloth at a lower price.

Lace. Lacemaking preceded the weaving of cloth; man made snares and nets before he conquered the intricacies of weaving. Lace is a meshlike fabric made of knotted yarns following a regular or definite pattern. The production of handmade lace was one of the most important industries of the Venetians during the Renaissance. The pattern, size, and quality of yarns distinguishes each of the various types of lace: Venetian, Chantilly, Rose-point, Alençon, Valencienne, Irish crochet, filet, and so on. Machine-made lace duplicates one or more of the traditional handmade lace patterns. Lace is used for such apparel as evening gowns, blouses, and veils, as well as for curtains, tablecloths, and bedspreads; narrow laces are used as insertions for lingerie, on hats, and in dresses. Knitting, crocheting, and tatting are forms of lacemaking.

Braided Textiles. Braiding is the intertwining of yarns in narrow widths to produce shoe laces, straw braid for hats or table mats, trimmings, etc.

Rolled Textiles. Rolling with steam and pressure or other means transforms fibers into an even, compact, opaque sheet. Felt is made in this manner from wool or fur fibers which become interlocked under heat and pressure. Rubber and plastic materials are also rolled, and in 1947 a process was perfected by which low-grade cotton fibers were made to adhere in an inexpensive paperlike substance. Such fabrics have a variety of uses in both the apparel and the home-furnishings fields.

*Finishing.* Fabrics are finished to remove foreign particles and sizing, and to improve the appearance. Finishing processes include chemical bleaching, dyeing, printing, mercerizing, sanforizing, crease-resistant finishing and finishes that produce a degree of water-repellency. Through these finishing processes yarns are improved in appearance and versatility. Low-cost yarns are made to resemble more costly fibers. Napping, the roughing up of the surface, is used on cotton or outing flannel and blankets. Mercerizing makes cotton stronger and imparts a silklike luster. Glazing adds a smooth, glossy finish to cotton chintz.

### COTTON AND LINEN FABRICS

Typical cotton and linen fabrics include the following:

Batiste: a soft, light, high-count combed cotton, used for infant's wear, blouses, and lingerie.

Bird's-eye or Diaper Cloth: a novelty weave used to produce a soft, absorbent material for diapers and towels.

Broadcloth: a plain weave fabric having a fine cross-wise rib and a count indicating approximately twice as many warp as filling yarns, as 120 by 64 used for shirts, children's and women's dresses.

Byrd Cloth: a plain weave, tightly woven fabric made from combed ply yarns. Developed for explorers under Commander Richard Byrd, it is used for windbreakers and raincoats.

Calico: a plain weave printed fabric, in small motifs, used for aprons and dresses. Originally all fabric from Calcutta, India, was classed as calico.

Cambric: a soft, light, plain weave cotton used for aprons and lingerie.

Canvas: a heavy, stiff, tightly woven cloth used for awnings, tents, sails, and tennis shoes.

Chambray: a plain weave, medium-weight fabric made with colored warp and white filling, desirable for shirts, dresses, blouses, and pajamas.

Chintz: a usually lustrous plain weave fabric, brightly printed or in plain color, used for dresses, curtains, and bedspreads. The frequent glazed finish is available in washable finish which is not destroyed by laundering.

Corduroy: a pile fabric, resembling velveteen, with lengthwise wales, made in various weights for children's play clothes, dresses, robes, upholstery, and sports wear.

Covert: a cotton fabric resembling wool covert which has a steep twill and a two-color warp, used for work clothing and children's overalls.

Crash: a plain weave cloth made from uneven and irregular yarns, used for dresses, tablecloths, or draperies.

Cretonne: a plain weave medium-weight fabric in bold print patterns used for curtains, draperies, and bedspreads.

Damask: cloth with a large Jacquard woven design com-

bining plain and satin weave in decorative effect used for dress goods, tablecloths, napkins, drapery, and upholstery. Damask is generally in one color while brocade is multicolor.

Denim: heavy twill weave cloth with colored warp and white filling, used for overalls and other work clothing and sports wear.

Dimity: a sheer crisp cloth having lengthwise or checkered self cords, used for dresses, blouses, and curtains.

Drill: a medium or heavy closely woven twill used for middies and work clothing.

Duck: a plain weave fabric used for tents, awnings, and couch covers, similar to but lighter in weight than canvas.

Flannelette and Outing Flannel: a soft napped fabric used for nightgowns, summer blankets, pajamas, and diapers.

Gabardine: a cotton fabric of medium weight of closely woven twill weave made to resemble wool gabardine, used for shirts, slacks, dresses, and summer sports wear.

Gingham: a characteristic yarn-dyed cloth of medium weight, identified by woven checks, stripes or plaids, used for clothing and draperies and bedspreads.

Grenfell Cloth: a tightly woven cloth made at the suggestion of Sir William Grenfell as an ideal low-price clothing, wind resistant and water-repellent.

Lawn: a high count, plain weave cloth woven of fine yarns with a crisp finish, used for dresses, blouses, and lingerie.

Madras: a yarn-dyed check, striped or plaid fabric originally from Madras, India, used for shirts, pajamas, and dresses. Hand-woven Madras in unusual color effects is used for neckwear, hatbands, etc.

Marquisette: a sheer, soft fabric of leno construction, used for curtains, blouses, and evening dresses. This cloth is now made with nylon or rayon for glass curtains, evening dresses, and lingerie.

Monk's Cloth: a coarse, heavy, loosely woven basket-weave construction used for draperies and couch covers.

Muslin: a plain weave, medium-weight cloth, coarser and of lower count than percale, used for sheets, mattress covers, and apparel. A typical construction in muslin is 64 x 64, 64 square, meaning 64 yarns are used in the warp and an equal number in the filling.

Nainsook: a semisheer of plain weave, soft fabric, heavier than batiste, and softer than organdy, used for blouses and infant's wear.

Organdy: a sheer, starched, plain weave fabric, used for dresses, curtains, and bedspreads. A permanent finish organdy retains its crispness after washing.

Osnaburg: an inexpensive plain weave heavy fabric with small flecks of cotton stalks remaining, used for sacking, also bedspreads and curtains.

Oxford Cloth: a soft shirting woven in a basket weave, generally solid color but also in stripe effects, used for shirts and sports clothing.

Pajama Checks: an inexpensive low-count medium-weight fabric with small checks made by weaving several warp or filling yarns together, used for men's underwear.

Percale: a plain weave medium-weight fabric of finer texture and count than muslin (80 by 80 is a typical construction), used for shirts, dresses, sheets, and sports wear.

Piqué: fabric of medium-weight having lengthwise cords or novelty honeycomb texture, used for dresses, men's shirts and sports wear.

Plissé: a plain weave fabric, solid color or printed, having an all-over puckered surface produced by chemical means. It is used for underwear, housecoats, and play clothes, and does not require ironing.

Poplin: a coarse broadcloth used for shirts, pajamas, and dresses.

Sateen: a cotton satin made with filling floats that produce a lustrous surface, used for draperies, bedspreads, and linings.

Seersucker: cloth with a permanent wrinkle effect produced by uneven tension in the warp yarns. Generally produced in colored stripes, and used for summer suits and sports wear.

Shantung: a cotton cloth similar to broadcloth with uneven slub filling yarns, used for dresses and children's wear.

Suiting: cotton or linen fabrics, heavier in weight than dress fabrics, generally made to resemble wool or worsted suitings in herringbone or twill weaves.

Swiss, Dotted: a sheer, crisp fabric covered with dots either woven or chemically applied, used for dresses, aprons, and curtains.

Terry Cloth: a looped pile fabric in a variety of patterns, used for toweling, rugs, and beach robes.

Theatrical Gauze: a plain weave open fabric made in linen, used for draperies and stage sets.

Ticking: tightly woven striped twill fabric of medium weight, used for mattress and pillow coverings and sports wear.

Velveteen: a cotton velvet, having short closely packed cut pile, used for dresses, coats, draperies, and upholstery.

Voile: a plain weave, two-ply fabric, semisheer, used for dresses, blouses, and curtains.

### SILK AND RAYON FABRICS

Typical silk and rayon fabrics include the following:

Brocade: a medium-weight silk fabric with multicolor decorative design in Jacquard weave, used for drapery, upholstery, dress, and tie fabrics.

Broché: a brocade fabric resembling embroidery, having distinct face and reverse side with long floats on the reverse.

Chiffon: a silk sheer of gossamer lightness used for dresses and lingerie.

Crepe: a fabric of many varieties, depending on the kind of yarn used for warp and filling, the count, and finish. These textures include sheer semitransparent chiffon, a sheer plain weave; georgette, slightly heavier in weight with crepe yarns used in both directions, warp and filling; crepe-de-chine, medium-weight, made from a characteristic yarn from China, generally washable; flat crepe, similar to taffeta, a plain weave having very little creped effect; romaine, heavier in weight and less creped than georgette; Canton crepe, the heaviest of all silk crepes, with a noticeable crosswise ribbed effect; and satin crepe, a reversible satin with close face, having a high count, tightly woven. Other crepe constructions are made with fine worsted wool filling.

Foulard: a twill weave, medium-weight fabric, generally printed in small motifs, used chiefly for ties and dresses.

Lamé: any material woven with a metallic or simulated metallic yarn. Brocaded designs are frequently used to display a decorative pattern for evening wear. Nontarnishable and washable aluminum yarn of various colors is combined with cotton, wool, or rayon for street and sports wear.

Lastex: a yarn made from rubber, covered with silk, rayon, or cotton, used either interwoven or for a puckered effect obtained by stitching; popular for bathing suits and other sports wear.

Pongee: a plain weave, medium-weight fabric, having irregular yarns and the characteristic tan color of wild silk. Pongee is generally washable, used for dresses, blouses, sleeping garments, and curtains.

Satins: made with a long float on the surface in an irregular twill weave, producing a highly lustrous face. Various types of satins include a light-weight washable satin used for blouses and lingerie; crepe-back satin, panne satin, high polished in the finishing; slipper satin, made with silk warp and cotton filling; ciré satin, a glossy finished satin, used for millinery in ribbon or broad goods.

Shantung: a plain weave fabric made in dress and suiting weights, with irregular nub yarns, not unlike pongee in texture and appearance.

Sharkskin: a heavy taffetalike rayon in suiting weights with a heavy crisp hand, used for sports wear and suits.

Silk Lace: a fragile and delicate type, made in various patterns, especially for veils and evening gowns. Silk and rayon are used for both hand-made and machine-made silk laces.

Surah: a twill weave silk or rayon fabric of fairly heavy weight, used for men's ties, women's tailored dresses and suits.

Taffeta: a plain weave, opaque silk fabric of medium-weight, used for ribbons, dress fabrics and draperies. Iridescent taffeta is made by using one color of yarn for the filling and another for the warp. The fabrics known as faille, grosgrain, bengaline, and gros de Londres are all variations of taffeta.

Tulle: a sheer transparent netlike fabric, used for veils and millinery.

Velvets: pile fabrics produced by interweaving through the warp and filling yarns a third set of yarns making the pile. Velvets are sometimes woven double and the pile cut after weaving. Others are made by having the pile looped around wires. Uncut velvet, like Brussels carpeting, has the pile in one continuous strand. The texture resembles a terry cloth towel. Velvets are made of various combinations of yarns with either a silk back and pile, as in all-silk velvet; a silk back with rayon pile, as a transparent velvet; and Lyon's type, medium to heavy weight, having an erect pile and stiff taffeta-like back. Chiffon velvet has a short, lustrous pile. Velour is similar to velvet with a long pile. Panne velvet has a lustrous surface produced by pressing the pile flat.

## WOOL AND WORSTED FABRICS

Typical wool and worsted fabrics include the following:

Albatross: a light-weight, soft, fine quality worsted cloth similar to sheer crepe, but having a more pronounced texture than challis; used for blouses, dresses, scarfs, and children's clothing.

Astrakhan: a coating made to imitate the fleece of the astrakhan or Persian lamb; a pile cloth with a distinctive curled finish.

Baby Flannel: a light-weight plain or twill weave washable flannel for blankets and infants' robes.

Barathea: originally a tie silk, with a pronounced broken filling effect, used for men's evening wear in fine worsted, now made in women's suiting and coating.

Basketweave: a loose-textured fabric having two or more yarns woven together, resembling basket work. Sometimes a bouclé yarn is used to obtain this effect.

Bedford Cord: a clear-finish worsted cloth, having longitudinal cords used for coatings, suitings, riding habits, and uniforms. It is a hard-finish, long wearing and durable cloth. The cord effects may be in different widths. Cotton piqué is made in a similar construction.

Bird's Eye: a clear-finish worsted suiting, marked by small woven indentations resembling the eye of a bird.

Blanket: the experimental fabrics woven by a mill in producing new color effects. Blanket cloth used for women's coats, generally woolen, is heavily napped and fulled.

Bouclé: from the French meaning "buckle" or ringlet; any cloth made from looped yarns.

Broadcloth: a napped and polished face-finish coating and suiting, generally in a twill weave.

Brushed Wool: any woven or knitted cloth that has been finished by being napped or teaseled. Coatings are made with long, shaggy effects.

Camel's Hair: dress fabric, suiting, or coating cloth or knitted goods made from the fibers obtained from the camel; the cloth used for polo coats, distinctive in color. A napped woolen is a favorite with American women.

Cashmere: cloth made from the downy fiber from the Cashmere goat. Light in weight, yet exceedingly warm, the material is rare and expensive.

Cassimere: medium-quality suiting, frequently in herringbone weave and made from a combination of wool and worsted yarns.

Cavalry Twill: a durable steep twill showing a double diagonal stripe; also known as élastique, used for army uniforms, as well as coatings and suitings.

Challis: a plain weave, light-weight woolen or worsted cloth, in solid color or printed in distinctive motifs, used for children's wear, dresses, blouses, robes, and scarfs.

Check: a pattern of regular woven squares, such as Shepherd's check, pin check, etc.

Cheviot: a suiting and overcoating made in a twill weave, closely woven, originally from wool from the Cheviot Hills in Scotland; made with stock-dyed or piece-dyed yarns, ideal for casual wear.

Chiffon: originally a silk sheer of gossamer lightness, but also a term meaning light in weight, as a chiffon worsted.

Chinchilla: a type of fur and also a coating made with a twisted curled pile; a durable, attractive cloth for children's coats and sports wear.

Chlorinated Wool: a treatment in the finishing of wool which decreases shrinkage.

Covert: a coating fabric with a steep twill in either worsted or woolen yarns. Generally two colors are used in the warp. Originally the fabric was used for hunting jackets, but now is considered desirable for both town and country wear.

Cravenette: a registered trade-mark name for a water-repellent finish used for rainwear.

Crepe: a worsted, light-weight dress goods made with tightly twisted yarns, generally having a clear finish. Crepe woolen, heavier weight cloth, also crinkled, used for coatings and suitings.

Cross-dyed Cloth: generally a material made with wool and silk, rayon, or cotton yarns that produce a contrasting color effect when dyed.

Diagonal: a twill weave cloth with a pronounced diagonal stripe. Generally twill weaves run from lower left to upper right on an angle of 45, 63, 70, or 75 degrees. A herringbone is a reverse twill.

Dobby: any cloth having a small woven motif in check, dot, square, or lozenge.

Doeskin: a finish used on suitings and coatings, producing a soft, slight nap, and a smooth face. Doeskin finish is used on various types of constructions. The nap is shorter and more compact and used for fleece-type coatings. The appearance resembles duvetyn, a napped spun-silk fabric with a close face. During pioneer days in America, real buckskin or doeskin was used for men's trousers and jackets.

Donegal: a type of tweed-like fabric generally made with

white wool, colored filling, and pronounced nubs in bright colors; it is usually woven in herringbone, but it also appears in plain weave. It is available in dress, suiting, and coating weights.

Dress Worsted: fine quality, face-finished suitings originally made for men's evening clothes, but now used for women's town and afternoon suits and coats, as distinguished from sports wear and casual fabrics.

Élastique: *see* Cavalry Twill.

Éponge: meaning spongy, generally a plain weave cloth loosely woven of soft novelty yarns.

Face-finished Fabric: coatings and suitings napped and otherwise treated to obtain a distinctive effect in contrast to clear-finished fabrics, which reveal the weave clearly. Face-finished fabrics include chinchilla, unfinished worsteds, fleece, saxony, and broadcloth.

Faille: a plain-weave fabric with heavy filling yarns that produce a cross-ribbed effect; generally made in silk or rayon yarns, but now available in all-worsted yarns for dress and suitings.

Fancy: any novelty-woven or textured fabric that does not conform to a recognized standard construction.

Felt: matted, compact material made with heat and pressure, causing woolen fibers to be interlocked into a firm opaque mass. Fine quality felts are also blended with beaver or rabbit fur. It is used for hats, women's sports wear, table coverings, etc. Cotton felt is made in very cheap grades.

Flannel: a twill weave wool-worsted or combination fabric made in various weights, either in stock-dye or piece-dye with a slight napped finish.

Fleece: overcoating and topcoating made with a napped surface, generally from a woolen yarn in a twill weave. All kinds of fibers are used, such as camel's hair, fine wool, and mixtures.

Fur Fabrics: materials made from yarns in which a certain percentage of beaver, rabbit, mink, or other fur fibers is used for a distinctive color and texture effect.

Gabardine: a twill-weave clear-faced worsted cloth made in a variety of weights from 8 to 16 oz. The yarns are tightly twisted, and the twill is generally at 63 or 70 degrees and shows a different appearance on the reverse side; one of the most costly, yet most popular, of worsted fabrics; the construction is copied in other kinds of yarns.

Granite Cloth: an irregular pebbled weave used in dress crepes and suitings; a variation of the plain weave.

Gun Club Checks: sports wear fabrics with three colors of yarn used in warp and filling, regularly spaced as 6 and 6 in each color, both warp and filling.

Heather Mixture: named for a small white-pink or bluish-pink flower from the Scottish highlands; multicolor effects in cloth, as blue and lavender, resembling the attractive appearance of the flower.

Herringbone: in weave, a reverse twill; also descriptive of sports wear fabrics, dress, suitings or coatings, either wool or worsted, which are generally yarn-dyed and given a natural finish.

Homespun: originally cloth made from yarns spun by housewives, generally irregular and coarse. Homespun fabric is generally rugged and sturdy in character, used for sports wear. Tweeds are of the same classification.

Honeycomb or Waffle Cloth: a novelty raised effect produced with an unusual arrangement of warp and filling, resembling the distinctive cellular comb of the honey bee or the iron form used for making waffles.

Jacquard: any fabric woven with a large decorative design, regardless of fiber content.

Jersey: a knitted cloth in plain stockinet or ribbed stitch, also the slipover sweater.

Kasha: a trade-mark name for a twill-weave woolen fabric decorated with dark goat hairs.

London-shrunk: a type of finish used on worsteds in which the cloth is subjected to both hot and cold water, steam and pressure. The finish removes excess shrinkage.

Melton: an overcoating in quality yarns that resembles a heavy, dull-finished broadcloth. It is tightly woven, and the finish is napped, then sheared.

Merino: fine-quality worsted wool.

Metallic Cloth: any fabric woven or knitted with metal, gold, silver, or aluminum, yarns or simulated metal. Originally real gold was used for luxurious cloths for ecclesiastical vestments and altar hangings. Aluminum yarns are now used with wool or worsted yarns, both woven and knitted, for dresses, coats, and suits.

Mohair: cloth made from the hair of the angora goat; popular for tropical worsteds, and also used for upholstery.

Nap and Napped Fabric: the finish used in fabrics produced by raising the surface of protruding fibers to gain additional warmth. Typical napped fabrics include fleece, coatings, so-called unfinished worsteds, and blanket cloth.

Nun's Veiling: a sheer, light-weight, worsted fabric in plain weave, generally of a solid color, especially woven for religious dress, but sometimes used for dress goods.

Overplaid: a distinctive plaid effect that appears to be a double plaid; a large open-work plaid covering a small check. The Glen Urquhart is typical.

Oxford Cloth: fabric made from a mixture of black and white yarns which produces various effects in light or dark greys. The fiber is blended in the stock.

Palm Beach: a trade-marked summer-weight suiting generally containing mohair yarn. Tropical worsted is a light-weight cloth, in plain or twill weave, made of worsted yarns. Because of its popularity, it has been copied in less expensive yarns, which must be identified.

Rabbit Hair: rabbit fur which is sometimes combined with wool and worsted fabrics to produce a soft, lustrous finish, particularly desirable for dress goods.

Ratiné: cloth made from curled yarns similar to bouclé.

Saxony: high-grade wool produced in Germany, popular in suiting and coating weights, made in herringbone or twill weaves, or resembling tweed.

Serge: a closely-woven, clear-finished worsted cloth having a 2 up and 2 down 45-degree twill, one of the most durable of all worsted fabrics, noted for long wear. It is usually piece-dyed and made in all weights. Blue is the favorite color.

Sharkskin: a tighty-woven worsted fabric with a small, indistinct color effect produced with both warp and filling of contrasting colors. Rayon sharkskin is a plain-weave heavy cloth with an irregular surface.

Shepherd's Check: a small, all-over regular checked effect in dark color with white, generally worsted with four black alternating with four white yarns, both warp and fillingwise.

Shoddy: remanufactured wool obtained from worn garments pulled apart by a garnetting machine. Generally shoddy contains both wool and cotton yarns.

Velour: a napped finish used for felt of fine quality; also a closely-napped, soft, tightly-woven wool fabric of fine quality. This is a face-finished cloth used for luxurious coatings.

Venetian: a closely-woven, steep twill, lustrous fabric, generally used for suitings and coatings, said to be originally from Venice, which excelled in the production of fine quality cloth.

VICUÑA: fibers from the vicuña, an animal living in the high mountains of Peru, Bolivia, and Ecuador. The fibers are exceedingly fine and soft, strong, resilient, and golden chestnut to rich fawn in color; one of the most costly fibers used in the textile market.

VIRGIN WOOL: new or unused wool, as distinguished from reworked or reprocessed wool.

WOOL: fibers from the fleece of the sheep and animals of the so-called specialty fiber group, including the angora and cashmere goat, the camel, llama, and vicuña.

WOOL PRODUCTS: any cloth containing wool either new, reprocessed, or reused, that must be clearly identified as to content.

WORSTED: cloth made from long-staple choice stock, closely woven; used as dress fabrics, suitings and coatings. The finish may be either clear, natural, or face-finished. It is one of the most durable and attractive of all wool fabrics. *See also* CELLULOSE; COTTON; DYES, TEXTILE; FLAX; SILKWORM; SYNTHETIC FIBERS; WOOL. B. G. C.

**THACKERAY, WILLIAM MAKEPEACE** [thæ'kəri] (1811-1863), English novelist, was born July 18, 1811, at Calcutta, India. His father, a wealthy official, died four years later, and in 1817 the boy was sent to England to be educated. Loneliness and the rough conditions of boarding schools soon caused him to mask his sensitive feelings with comedy and sarcasm. At Charterhouse School, London, from 1822 to 1828, he was too lazy to study hard, but became popular for comic drawings and verses. He attended Trinity College, Cambridge, for more than a year, but had no clear plans for a profession and seized the first excuse to withdraw.

After some months in Germany he began legal studies in London; but when he came of age and inherited his patrimony he went to Paris as an art student. Extravagant habits and card-playing were eating into his funds, and he lost money by buying and editing a literary weekly, *The National Standard,* which failed in less than a year. Finding that he was unlikely to become a good painter, he made efforts to get commissions as an illustrator of books, and began to write sketches for magazines. In August, 1836, he married seventeen-year-old Isabella Shawe. At this time he became Paris correspondent for *The Constitutional,* a new Liberal daily in which his stepfather was a shareholder. Later for a short while he was managing editor, but in June 1837, the paper collapsed, financially ruining Thackeray.

As a book reviewer for *The Times* and a contributor of humorous tales and essays to *Fraser's Magazine* and other periodicals, Thackeray contrived to earn a living, but no literary reputation, as his identity was concealed under such pen-names as Charles James Yellowplush, Major Goliah Gahagan, and Michael Angelo Titmarsh. A pirated edition of his *Yellowplush Correspondence* was printed in Philadelphia in 1838. His first book of any size was *The Paris Sketch Book* (1840), soon followed by *Comic Tales and Sketches.* Both were collections of his magazine contributions, illustrated with his own drawings.

Three daughters had been born between 1838 and 1840, the second dying in infancy. After the birth of the third, Mrs. Thackeray developed mental illness, and had to be kept under restraint for the fifty-four years which remained of her life. About this time Thackeray had attempted longer works of fiction as serials in *Fraser's Magazine,* but both *A Shabby Genteel Story* and *The Great Hoggarty Diamond* were handicapped by his family troubles. In 1842 he toured Ireland to get material for *The Irish Sketch Book,* a pleasant travel book, which was followed by *From Cornhill to Grand Cairo* (1846), a similar record of a trip to the Near East. Both books showed impartiality and good sense on controversial issues.

From 1842 onward he was a regular contributor to the recently-founded comic weekly *Punch,* winning particular success with *The Snobs of England* and *Punch's Prize Novelists* (parodies of contemporaries). By these latter, as well as by outspoken criticisms of books and art exhibitions, he made some enemies through his indiscreet satire. Though still unknown to the general public, he was by now a familiar figure among the journalists and hack writers. Humorous poems in *Punch* showed another side of his talents. A historical novel, *Barry Lyndon,* appeared in *Fraser's* during 1844; and in January, 1847, he began to publish in monthly installments his first long novel, *Vanity Fair,* which soon caused him to be bracketed with Dickens as the leading novelist of the day. While some readers complained that he was digressive and cynical, others admired his easy, unpretentious style, his wide knowledge of upper-class life in England and on the Continent, his satiric wit, and his sudden bursts of sympathy.

Burdened with the support of his wife and young children, and aware of permanent impairment of his health, he became obsessed with a determination to earn money equivalent to the inheritance he had lost. Living irregularly in clubs and lodgings, eating and drinking unwisely, he found his chief happiness and encouragement in the friendship of two persons—a college comrade, W. H. Brookfield, and Brookfield's beautiful wife. The success of *Vanity Fair* enabled him to establish a home for his daughters and made him popular in London society. He enjoyed aristocratic circles so frankly that some colleagues accused him of snobbishness.

His second novel, *Pendennis* (1848-1850), was largely based on his own early career. In hope of further profit from his new fame, he undertook a series of public lectures on *The English Humorists,* which he delivered successfully throughout England and Scotland, though he suffered torments before an audience. His next book, *Henry Esmond* (1852), a historical romance, was tinged with melancholy arising from complications in his relations with the Brookfields.

The winter of 1852-1853 was spent in a lecture tour of the United States, where he was happy and made many friends. Upon his return to England he wrote *The Newcomes,* another novel embodying family and personal experiences. On a more extensive American tour in 1855 his lecture topic was *The Four Georges,* and he later gave these lectures widely in his own country.

Suffering increasing pain from his chronic ailment, and always hoping to escape from the drudgery of authorship, he applied at various times for appointment in the postal department, in the foreign service, and as a London magistrate. In 1857 he was Liberal candidate for the House of Commons at an election at Oxford, and was narrowly defeated.

*The Virginians* (1857-1859), his last long novel, was a sequel to *Henry Esmond.* In 1860 he became the first editor of *The Cornhill Magazine,* and its success brought the full prosperity he had long sought. Two short novels, published serially in the magazine, showed a decline in his powers, and he was happier in a monthly series of informal essays, *The Roundabout Papers.* After two years he resigned the editorship and applied himself to another historical novel, *Denis Duval.* It was unfinished at his death, which occurred Dec. 24, 1863. *See also* HENRY ESMOND; NEWCOMES, THE; PENDENNIS; VANITY FAIR; VIRGINIANS, THE. L. St.

**THAILAND.** *See* Siam.

**THAÏS** [ta·i's], a French historical and philosophical novel by Anatole France (1844-1924), published in 1890. It retells in a graceful and poetic style the legend of the conversion of the famous courtesan of Alexandria, Thaïs, by the desert monk, Paphnutius. At the end of the novel she retires from the world to become a hermit saint in the desert. Both parties to the conversion had been deluded: Thaïs had mistaken a promise of eternal salvation for one of eternal beauty, while Paphnutius discovered that he had been more interested in the beauty of Thaïs' body than in that of her soul.

The symposium in the famous banquet scene at the home of Thaïs presents the views of the various schools of philosophy in Alexandria in their clash with Christianity, the Christian faith being represented in the person of the ignorant monk, Paphnutius. France's own skepticism and his dislike of Christian asceticism permeate the discussion. Both critics and scholars have praised the accuracy of the novel's evocation of the historical period, and it has also been the most widely read of France's works. The libretto of Massenet's opera *Thaïs* is based upon the novel. J. F. M.

**THAKUR.** *See* Asiatic Tribes (*Indo-Iranian*).
**THALAMUS.** *See* Brain.

**THALES** [the'liz] (c. 624-546 B.C.), Greek philosopher and founder of the Ionian school, was born in Miletus in the latter half of the seventh century B.C., perhaps of Phoenician stock. He is known as the father of Greek philosophy and was numbered among the Seven Wise Men of Greece. Thales achieved fame as an astronomer for predicting an eclipse of the sun calculated to have occurred in May 585 B.C. He was also an able statesman and tried to unite the Ionian cities in a defensive confederacy against the Persians. A military engineer in the service of Croesus, he is said to have diverted the course of the Halys River, and as an astute man of affairs, he at one time established a monopoly in olive oil. Tradition claims that he introduced abstract geometry, knowledge of which he had acquired during a stay in Egypt, to the Hellenic world.

No authentic writings of Thales are extant, and knowledge of his doctrines is based entirely on secondary sources, especially on the account given by Aristotle (*Metaphysics* I, 3). Thales asserted that water was the origin of all things, that is, that it was that out of which everything arose and into which everything resolved itself, basing his inference, according to the conjectures of Aristotle, on the observation that many elements essential to life (nourishment, heat, seeds, and so forth) contained moisture. Aristotle also attributed to Thales the sayings that "all things are full of gods" and that "the magnet has a soul because it attracts iron." The general doctrine of animism inherent in Thales' philosophy—that is, the belief that matter is imbued with life and has a soul (sometimes termed hylozoism)—was a tenet common to all the earlier Ionians and does not necessarily imply that Thales believed in the existence of a world soul. Thales' claim to be the father of Western philosophy lies in the fact that he faced the problems of philosophical inquiry squarely, basing his conjectures on observations that were both scientific and methodical. C. W. D.

**THALIA.** *See* Graces; Muses.

**THALLIUM** [thæ'liəm], symbol Tl, atomic number 81, at. wt. 204.39, density 11.85, m.p. 303.5° C., b.p. 1,650° C. Thallium (Greek *thallos,* budding twig) is the last member of Group III-B of the periodic table. It closely resembles indium and gallium and is more distantly related to aluminum and boron. The atom of thallium has five completed shells of electrons (2, 8, 18, 32, 18) with an outer shell of three. It is a typical metal, with valences of 3 and 1. Thallium is a white metal with a bluish tint, soft enough to leave a mark on paper; it lacks ductility and elasticity, and is only slightly malleable. Its thallous compounds resemble the compounds of alkali metals; they are highly ionized in solution. The thallic salts are stable only in the presence of acids and are considerably hydrolyzed in solution. Thallium compounds are cumulative poisons and as such are used for exterminating rodents. B. S. H.

**THALLOPHYTES** [thæ'lofaits], one of the four main divisions of the plant world; this group embraces all of the flowerless plants that have no vascular system. The algae, fungi, and lichens, some of which are wholly microscopic, are included in the thallophytes; their method of reproduction is usually by spores, although some variations occur. These plants have no roots, leaves, or stems; the plant body is usually a thallus, the most familiar example of which is the seaweed. *See also* Algae; Fungi; Lichens. F. J. S.

**THAMES** [tɛ'mz], the principal river of England. It rises at Thames Head in the Cotswold Hills of Gloucestershire and follows a winding easterly course 209 mi. to the North Sea. The river is tidal up to Richmond, and the fall of 365 ft. to sea level is controlled by 44 locks, enabling barges to navigate as far as the junction of the River Colne at Lechlade in Gloucestershire. The Thames forms boundaries for Gloucestershire, Oxfordshire, Buckinghamshire, Middlesex, Essex, Wiltshire, Berkshire, Surrey, and Kent, and is believed originally to have formed part of a great river system reaching far into the western Midlands. There are nine main tributaries; the Colne, Leach, Windrush, Evenlode, Cherwell, Thame, Kennet, Wey, and Medway. Of the canals connecting the river with other waterways, the Grand Junction and the Union are the most important.

Scenically, the most beautiful reaches are between Oxford and Cliveden, near Windsor. Narrow from its head to Oxford, the Thames Valley widens to 21 mi. at Oxford, narrows to 1 mi. at Goring, then broadens into the great basin 100 mi. long and averaging 30 mi. wide, of which Greater London is the center. The estuary commences at Tilbury, and extends to the Nore lightship off Shoeburyness. In addition to London, the principal towns and cities on the banks are Oxford, Abingdon, Wallingford, Reading, Henley-on-Thames, Marlow, Maidenhead, Windsor, Staines, Kingston, Richmond, Greenwich, Gravesend, and Tilbury.

The use of the Thames is controlled by two official bodies, the Thames Conservancy Board, whose authority extends from the headwaters to Teddington, and the Port of London Authority, which controls the remainder. The conservancy board controls the navigation, use, and conservation of the river water, its pollution, flood prevention, and fishing, and is associated with the drainage board of the catchment area. B. Su.

**THAMYRIS** [thæ'mɪrɪs], in Greek mythology, a Thracian bard who presumptuously challenged the Muses in a contest of song. When defeated, he was deprived by them of his sight and of the power of singing. *See also* Muses. G. E. D.

**THANATOS** [thæ'nətɒs], in Greek mythology, the personification of death, the son of Night and brother of

Sleep (Hypnos, or Somnus). When Thanatos carried off Alcestis, Heracles forced him to give her up and return her to her husband Admetus. *See also* ALCESTIS. G. E. D.

**THANKSGIVING DAY.** *See* HOLIDAYS AND HOLY DAYS.

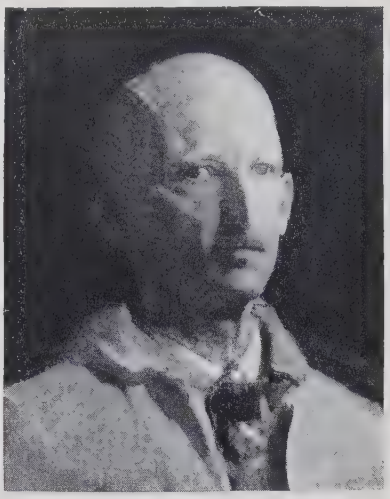
**THAR DESERT** or **INDIAN DESERT** [t·hʌr; tɑr], a desert 100,000 sq. mi. in area in northwestern India, between the Aravalli Range on the east, the Indus River on the west, the Sutlej River on the west and north, and the Gulf of Cutch and the Arabian Sea on the south. It is a sandy area with a few hills and waterless valleys and no vegetation except for a few patches of xerophytic plants. The rainfall is approximately 3 in. a year, increasing to 10 in. on the outer edge of the desert. The mean annual temperature is about 80° F., and during the summer daytime temperatures frequently reach 100° F. The desert cannot be irrigated because it is too far from the Indus River. Jaisalmer, one of the few towns in the desert, is the center of the camel routes across the heart of the desert. J. E. F.

**THÁSOS** [thɑ′sɔs; the′sɒs], the name of a Greek island and its chief town, in the northern part of the Aegean Sea, in northeast Greek Macedonia, 16 mi. southeast of Kaválla, and separated from the mainland by the Thásos Strait. It has an area of 170 sq. mi. The chief products of the island are olive oil, tobacco, maize, wine, honey, and timber; and there are marble quarries and fisheries.

The earliest known inhabitants of the island were the Phoenicians, attracted to Thásos by its valuable gold mines. They were led by Thásos, son of Phoenix, from whom the island derived its name. The island was afterward colonized by the Saians, a Thracian tribe, and in the eighth century B.C. by Greek settlers from Páros. The Greek colony rapidly rose in power and wealth and exploited the even richer mines on the adjoining mainland. In 492 B.C., Darius the Great compelled the Thasians to pull down their fortifications and to surrender their ships; and in 463 B.C. the Athenians, after a siege of two years, again exacted a heavy tribute and forced the Thasians to surrender their mainland possessions. After the battle of Aegospotamos in 405 B.C., Thásos passed into the possession of the Lacedaemonians. In the Roman wars in Greece, Thásos submitted to Philip V of Macedon, but received its freedom after the battle of Cynoscephalae (197 B.C.). The island was later held for a short time by the Venetians. The Turks conquered the island in 1462 and held it until 1912, when they were compelled to cede it to Greece. It is now a part of Kaválla District. The ancient city of Thásos on the north coast is now in ruins. Pop. 1951, 15,208. C. W. D.

**THATCH PALM,** common name of a genus, *Thrinax,* of small palms, natives of southern Florida, the West Indies, and Central America. Of about 10 species, four are found in dry and sandy places in southern Florida. The fan-shaped leaves are 2 to 4 ft. across, and are used widely for thatch and for making hats, baskets, and small cordage. The slender trunks, 20 to 30 ft. high, are used for piles in building small wharves. The wood is light and soft. J. C. Wis.

**THAYER, ABBOTT HANDERSON** (1849-1921), American painter and author, was born in Boston, Mass., Aug. 12, 1849. He studied at the National Academy of Design and later in Paris with Jean Léon Gérôme. Especially known for his idealized compositions of women and children, Thayer also painted landscapes and portraits in a wide variety of techniques. His many years of research on the subject of protective coloration in animals resulted in several publications. Thayer died in Monadnock, N. H., May 29, 1921. E. B. S.



*ABBOTT HANDERSON THAYER*

FROM A SELF PORTRAIT SKETCH

COURTESY OF THE MACBETH GALLERY—P. A. JULEY

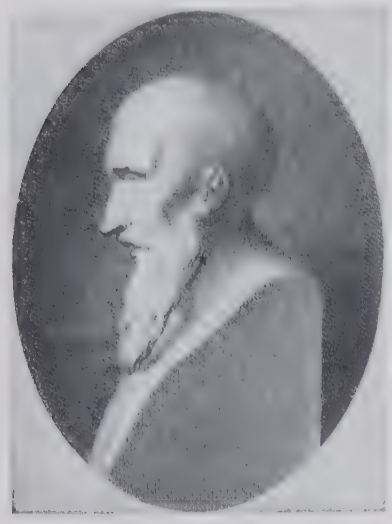
**THEA** [thi′ə], in Greek mythology, a Titaness, daughter of Uranus and Gaea. Wedded to the Titan Hyperion, she became the mother of Helios and Selene. *See also* TITANS. G. E. D.

**THEATRE,** from the Greek verb *theasthai,* which means "to see," a place where dramatic performances are produced and viewed.

**Oriental.** All legends point to the fact that the theatre evolved from ritual festivals and dances. Here lie the roots of the passion and coronation plays of ancient Egypt. China has her Pear Garden legend, which connects the origin of her theatre with the worship of the moon. Japan knows of sacred dances before the Heavenly Cave of the Ancestral Goddess, and Brahma was prompted by divine guidance to invent the drama in India. In all oriental cultures two theatrical strains are easily distinguishable, the aristocratic and the popular. In either instance, the theatre of the East makes an appeal to the unlimited power of imagination. It is a suggestive theatre, its stage frankly presentational, making no attempt to be realistic. The actor's gestures are symbolic, his costumes, masks, or make-up conventional; his voice has an artificial quality, and his movements are controlled by the rhythm of music. Everything is tuned towards the creation of a highly stylized world of beauty, which guarantees the oriental mind an absolute escape into the realm of art, an experience rarely accorded to the occidental.

**Ancient Greece.** When the tyrant Pisistratus assumed power over Athens (561 B.C.), the Athenians celebrated a number of yearly festivals in honor of Dionysus. One of these festivals, the Great or City Dionysia, featured lyrical contests in which hymns in praise of the god (dithyrambs) were sung. Pisistratus decided to make dramatic performances (such as could be seen in the Icarian peasant theatre of Thespis) part of the Dionysus celebration. Thus he stimulated dramatic production and laid the foundation for the flowering of Greek drama in the fifth century, when, at each spring festival, three dramatists competed for the first prize in the annual dramatic contest. Each playwright entered the competition with three tragedies and one satyric

play. The management of the drama festivals lay in the hands of the Athenian chief magistrates, who, assisted by curators, chose the playwrights, appointed the choral producers (*choregi,* wealthy citizens who paid for the training and the costumes of the chorus), and engaged the actors. The Greek playwright was restricted in the number of actors at his disposal. Thespis is credited with setting up the first actor, who carried on a dialogue with the spokesman for the chorus. Aeschylus introduced the second actor, Sophocles the third. The early Greek dramatists were their own stage directors and supervised the chanting and dancing of their actors and chorus. Later, special coaches were in charge of the training of the chorus. Originally, the tragic chorus consisted of fifty members. Aeschylus reduced their number to twelve, and Sophocles increased it again to fifteen. The chorus in comedy consisted of twenty-four members. Aristotle gave Aeschylus credit for having invented the tragic costume.



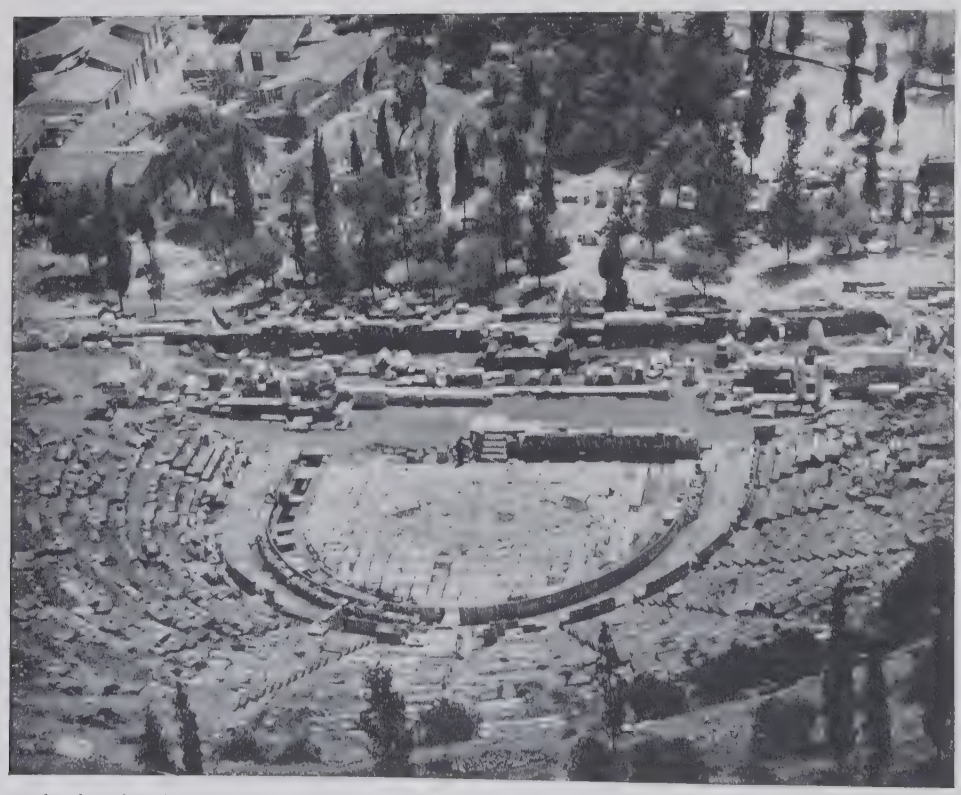
*AESCHYLUS*

CULVER SERVICE

**Roman.** The stages upon which the plays of Plautus and Terence were originally performed were long wooden platforms erected for special occasions in the Forum or in the arena of a circus.

Plays could be seen in Rome only on festive occasions in connection with the games (*ludi*), which were a combination of circus games, theatrical performances, and variety shows. During the course of the Republic these games grew more and more numerous, and a Roman playwright therefore had many opportunities to see his plays produced. The official in charge of a particular game hired professional companies which were owned by managers to whom the playwright sold his plays. Thus, in contrast to the Greek theatre, the Roman theatre was frankly commercial. These professional acting companies performed not only in Rome but also toured the provinces, visiting those Italian cities which had games of their own and permanent theatres which were, in a number of instances, older than those of the capital.

The majority of Roman actors were slaves and regarded as nothing better than vagabonds. Not until the art of acting reached its height in the first century B.C. was it possible for a prominent actor to acquire social prestige, such as was attained by the great comedian Quintus Roscius and the no-less-famous contemporary tragedian, Clodius Aesopus. Both actors acquired huge fortunes and trained their own students. It is probable Roscius introduced the mask on the Roman stage, and we gather from Cicero that the older generation did not particularly care for this innovation. In the original performances of the plays of Plautus and Terence the actors seem to have used make-up instead of masks. Women's parts on the stage of the Roman Republic were played by men. Under the emperors the interest in comedy



*THE THEATRE OF DIONYSIUS SEEN FROM THE ACROPOLIS*

CHARLES PHELPS CUSHING

and tragedy declined. The chief interest of the Romans was focused on the sensations of the circus, and in order to be able to compete with the spectacles in the amphitheatre, the stage also had to strive for sensationalism. Circus elements invaded the legitimate theatre. Animals, chariots, and armies of supernumeraries represented the empty splendor that attracted the masses, and the pantomimes of Bathyllus and Pylades tickled the palates of the connoisseurs.

**The Middle Ages.** The earliest medieval drama, the liturgical drama, was performed in the church itself. As secular elements, such as humorous incidents and prankish devils, forced themselves into the religious plays, the plays had to leave the church and were produced in front of it (Adam Play) and still later in market squares (Lucerne and Frankfort Passion Plays). The medieval stages were multiple stages; i.e., the various localities required in the play were represented simultaneously on the stage. These independent scenic units are known as mansions, e.g., Paradise, Hell, and Purgatory mansions. In the case of processional plays, such as flourished in England (York, Chester, and Coventry), Italy (Florence and Milan), and Spain (in all major cities in connection with the Corpus Christi festival), itinerant stages and pageant-cars rolled through the principal streets of the city and halted at predetermined points, where a scene of the (usually cyclical) play was enacted. The responsibility for the equipment of these pageants was in the hands of the local guilds, with the result that the performance of a mystery play became the affair of the entire community. Royalty attended the performances, and with them arrived the swarms of courtiers. The clergy, high and low, were always in the foreground, while the middle class and the country folk made up the colorful background for these true festivals of the people. During the later Middle Ages the mystery plays (liturgical dramas) grew more and more spectacular and sensational. There was a growing interest in the techniques of Biblical tortures and executions, an interest, however, which at no time precluded a most tender feeling and the flow of tears at the sight of the sufferings of Christ and the martyrs. For the medieval populace the religious drama was a most exciting and stirring reality.

**The Renaissance.** The Renaissance theatres were modifications of the theatres of antiquity. Information concerning the ancient playhouses was obtained by Italian architects from a treatise, *On Architecture,* which the Roman architect Vitruvius Pollio wrote in the time of Augustus. At the end of the fifteenth century, Vitruvius' study was rediscovered, and the story of the Renaissance theatre is a compromise between classical ideas, inherited from Vitruvius, and the overwhelming interest in the new art of perspective painting.

**Improvised Italian Comedy.** The term *commedia dell' arte* (also the older terms *commedia a soggetto* and *commedia all'improviso*) refers to the improvised comedy which flourished in Italy during the sixteenth, seventeenth, and eighteenth centuries. Leaving aside the highly controversial subject of the origins of improvised comedy, we can turn to certain features of the *commedia dell'arte* which had become standardized by the end of the sixteenth century. First, the characters were conventionalized to such an extent that we can distinguish certain stock personages who, under a variety of names and with certain local modifications, were seen again and again on the stages of the strolling players. Such stock characters were Pantalone, the doctor, the captain, the clowns (as a rule, two, one extremely clever, the other a booby), the young lovers, and the maidservant. Not only the types became standardized, but also their speeches and comic business. It would be wrong to assume that Italian improvised comedy was all improvisation. Each player was supposed to have at his or her command a sufficient amount of premeditated material, stock speeches in character, for instance, which could be used wherever the basic scenario (*soggetto*) required it. The impromptu players were, under the management of a *capocomico,* organized into traveling companies. Such major troupes as the Gelosi and Fedeli enjoyed the backing of aristocratic patrons, among them the Dukes of Parma, Mantua, and Modena, in whose castles they often had opportunity to perform. The minor companies, unrecorded by history, moved from town to town and erected their primitive trestle stages in the central squares for the entertainment of the populace. While the major companies had at their disposal the paraphernalia of courtly stages, the minor ones had to perform with a minimum of costumes before a crudely painted backdrop.

**Tudor England.** From the beginning of the sixteenth century the English mystery cycles fell into increasing disuse, as a result of the Reformation, the impact of the Renaissance, and the distintegration of the guild system. But part of the medieval heritage lived on in farces and morality plays, which were performed by strolling players in the yards of the carriers' inns. These early inn-yard playhouses became the model for the first London playhouse, The Theatre, built at Shoreditch, just outside London, by James Burbage in 1576. And as one playhouse after the other was built in and around London—the Curtain, the Rose, the Swan, the Globe, and the Fortune—they followed with minor changes the pattern which Burbage had set. English actors had finally achieved legal status (1572), provided they were organized into companies under the license of an aristocratic patron. Elizabethan acting companies were business organizations in which the guild system—with its masters, hired men, and apprentices—prevailed. The apprentices, attached to the full-fledged master members of the company, played the female parts. The hired men, receiving weekly wages, had to play minor roles and work backstage as propertymen or prompters. The full-fledged actors were shareholders in the company. They were cast along "type" lines. There were specialists for clowns, for distinguished gentlemen, for notorious villains, and for the young gallants. Shakespeare himself seems to have played the old men, their smaller parts giving him an opportunity to see to his duties as a stage director. He wrote his title parts for Richard Burbage, the star of the Lord Chamberlain's Men, later the King's Men. In the rival troupe of the Admiral's Men, Edward Alleyn held the corresponding position, most successfully in the title parts of Marlowe's plays. The acting style of the great Elizabethan actors must have been a formal or stylized one, and their gestures were of a conventional rather than realistic nature. Indeed, conventional was the whole production style on a platform stage that was on almost three sides surrounded by the spectators standing in the yard.

**Restoration in England.** The Restoration theatre was shaped by two companies, the Duke of York's Players and the King's Servants. The first was managed by Sir William Davenant, the second by Thomas Killigrew, courtiers of Charles II to whom he granted a monopoly for theatrical productions. The Duke's company played in the Duke's Theatre, first at Lincoln's Inn Field, later in Dorset Garden, London; the King's company's home was the Theatre Royal in Drury Lane. In 1682, the two companies merged into one, a union which lasted until 1695. Most prominent among the Duke's players were Thomas Betterton and Mrs. Eliza-

beth Barry, while Killigrew offered such players as Charles Hart, John Lacy, and the captivating Nell Gwyn. Regarding the use of costumes, only such characters as Falstaff and Richard III were dressed in the Elizabethan style, while the majority of characters, Hamlet among them, wore the fashionable dress of the day. Classical or oriental characters

*SIR WILLIAM DAVENANT*

CULVER SERVICE

were garbed in fanciful costumes. Nor was there any pretense to historical accuracy in the costumes exhibited by the actresses who, as Cleopatra or Portia, looked at their best in the elaborate dresses of the Stuart court. Only for the sake of travesty did Restoration players dress in character, and Nell Gwyn was always successful when she did so.

**Classical France.** Classical French drama was cradled in buildings that resembled tennis courts. In this group belong the two rival houses of the seventeenth century, the Hôtel de Bourgogne and the Marais Théâtre (where the première of Corneille's *Le Cid* took place in 1637). During the first third of the century, various itinerant companies occupied these theatres for a while. By the middle of the century two permanent companies were associated with these two playhouses, which received brisk competition from a company headed by Molière (Jean Baptiste Poquelin), who from 1658 to 1673 played in the Petit-Bourbon and the Palais-Royal theatres in Paris. In 1680, all French troupes were united into one French company by a royal decree, which is generally considered the birth certificate of the Comédie Française. While lavish *mise-en-scène* was bestowed upon the production of opera, French legitimate drama, subject to the rule of the unity of place, required only a minimum of scenery. The revolt against this scenic dearth in spoken drama came in the eighteenth century, when Voltaire clamored for more spectacle and the removal of the spectators from the stage. The latter were banned from the stage of the Comédie Française in 1759, and from then on there was an ever-increasing demand for more scenic illusion. Denis Diderot, encyclopedist and philosopher, and Pierre Augustin Caron de Beaumarchais, dramatist, author of *Le Barbier de Séville* and *Le Mariage de Figaro,* took up the pre-Revolutionary fight for a theatre that was to be closer to everyday life. They anticipated the drawing-room atmosphere which, a century later, was to become the standard scenery for the naturalistic playwrights. The French Revolution abolished the monopoly of the Comédie Française, and scores of new theatres were opened, in fact so many that Napoleon had to restrict their numbers in 1807, when four principal playhouses were licensed and four secondary ones, the latter limited to the productions of vaudeville and melodrama.

**Eighteenth-Century England.** During the eighteenth century two major theatres were built in London. In 1705, the Haymarket Theatre was opened. Originally destined to be the home of the Duke's company, it became in 1710 the permanent home of opera. In 1732 the Covent Garden Theatre was built. Covent Garden and Drury Lane were designated as the two patent theatres, which had the exclusive right for the production of legitimate drama. There were a few minor houses which, in contrast to the two major ones, were forced to specialize in the field of musical satire. It was on the stage of one of these minor theatres that David Garrick (1717-1779) made his London debut. The emergence of Garrick in 1741 marked a milestone in English theatre history, and there is justification in dividing the eighteenth century into three periods, the pre-Garrick era (from the death of Betterton in 1710 to the appearance of Garrick), the Garrick epoch (until his retirement in 1776), and the post-Garrick period. As an actor, Garrick strove for greater naturalness, which contrasted sharply with the pseudo-classical style in which Barton Booth and James Quin had employed in the pre-Garrick era. Nor did Garrick stand alone; his rival, Charles Macklin, had likewise embarked upon a course of greater truthfulness to nature. As a manager, Garrick introduced a series of reforms. In 1763, he barred the spectators from the Drury Lane stage (as had Voltaire in France in 1759) thus doing away with a convention that had been accepted on the English stage since the days of Elizabeth. The removal of the spectators from the acting area opened the path for greater

*CHARLES MACKLIN*

FROM AN ENGRAVING BY W. READ

CULVER SERVICE

realism in acting. Another of Garrick's reforms concerned the lighting of the stage. He had the chandeliers removed in 1765 that until then had illuminated not only interior scenes, but exteriors as well. From then on, the chief sources of light were the candles (or oil lamps) which were placed behind the wings in front of reflectors. Footlights were probably used from the early days of the Restoration. The reform of lighting was but another step towards realism. The stage was now free for the painter, who was to revive the forgotten craft of perspective scene painting, and for the mechanical devices for "transformation" scenes and atmospheric effects.

**Early American.** The beginnings are rather hazy, and it is hard to draw a line between amateur and professional play-producing activities. But Williamsburg, Va., Charleston, S. C. (the Theatre in Dock Street, 1736), New York, and Philadelphia, Pa., were the early focal points. The first

colonial acting company of any stature was that of Thomas Kean and Walter Murray, playing in converted warehouses and public halls in Philadelphia and New York. But this Virginia Company of Comedians was soon to be overshadowed by Lewis Hallam's company, which arrived from London in 1752. After Hallam's death, his widow with her second husband, David Douglass, carried on the fight of the American Company against Puritan intolerance. Douglass built the Southwark Theatre in Philadelphia (1766) and the John Street Theatre in New York (1767). After the Revolution, Lewis Hallam, Jr., was old enough to look after the affairs of the company which, in 1791, had to face the dangerous competition of a rival troupe, organized by Thomas Wignell, the builder of the Chestnut Street Theatre in Philadelphia (1794). The American Company met the challenge by erecting the Park Theatre (1798), which was to become the outstanding theatre of New York for the next fifty years. By the end of the eighteenth century even Boston had two playhouses, the Federal Street Theatre (1794) and the Haymarket (1796).

*CHARLES KEAN*

FROM A DAGUERREOTYPE BY PAINE OF ISLINGTON

CULVER SERVICE

**Towards Realism.** The two major English houses, Drury Lane and Covent Garden, had the monopoly for the production of legitimate drama in London until 1843, when, through the Theatre Regulation Act, freedom of the theatres was granted. This made it possible for managers like Samuel Phelps (Sadler's Wells) and Charles Kean (the Princess's Theatre) to stage their pretty Shakespearean revivals. On the stage itself, realism made steady progress. While the apron was in process of shrinking, the actors withdrew behind the proscenium frame; and the proscenium doors, which had formed the background for many a grandiose gesture of Mrs. Siddons, were abolished. Gas lighting was introduced in 1817-1818. There was also progress in the field of stage management. In 1831, Madame Vestris became manageress of the Olympic Theatre, where she advocated drawing-room realism in scenery and did away with the grotesque in burletta costumes and acting. In association with her husband, Charles James Matthews, she had a production style ready for a new English comedy of manners, which failed to appear. More successful in this respect was Marie Wilton (later Lady Bancroft), who managed the Prince of Wales's Theatre and discovered T. W. Robertson, whose "cup and saucer" comedy flourished under the Bancrofts. When they gave their last performance at the Prince of Wales's, the first translations of Ibsen's plays began to circulate in London, although Victorian society was not yet ready for the shock, and the Norwegian "dynamite" had to be handled in private performances.

**Naturalism.** Theatrical history was made one night in March, 1887, when, in a small wooden hall on Montmartre, Paris, André Antoine, in daytime a clerk in the gas company, opened his Théâtre Libre in protest against the conservatism of the Comédie Française and in defiance of the mercenary boulevard theatres and their well-made plays. Antoine had been inspired by Emile Zola and other apostles of naturalism, and while he was unable to carry out all the principles of naturalistic production on the first stage of his Théâtre Libre, he dreamed up a playhouse which would meet the requirements of the new art. It would be a playhouse of perfect scenic illusion, with no footlights and with actors oblivious of the timeworn stagy attitudes. One year later, Konstantin Stanislavsky returned to Russia from Paris and, disgusted with the staleness of Russian theatrical life, dreamed the very same dream. Stanislavsky (in association with Vladimir Nemirovich-Danchenko) finally realized his naturalistic ambition when the Moscow Art Theatre opened its doors in 1898, and each new play by Chekhov became for its director another stepping stone towards the final goal—the truth in the theatre. Antoine's Théâtre Libre had found imitators all over Europe; in Berlin a Free Stage had been launched in 1889 by Otto Brahm and nine other intellectuals, who deplored the fact that the economic expansion following the Franco-Prussian War of 1870-1871 had not been accompanied by any artistic advance. In 1894, Brahm became the manager of the Berlin Deutsches Theater, where he continued to stage plays by Henrik Ibsen and Gerhart Hauptmann in a naturalistic fashion. As a director, Brahm saw his goal in a psychological interpretation of character. Like Antoine and Stanislavsky, he asked of his actors moderation, restraint, and simplicity as well as complete submission to the ensemble idea. Scenically he followed to the letter the lengthy stage directions in which the naturalistic playwrights habitually indulged. He saw in shabby interiors a perfect expression of the dreariness of everyday life.

**Continental Impressionism.** At the turn of the twentieth century, the naturalistic revolution in the theatre was over, and there was knocking at the gates a new generation of playwrights, poets, and romantics with a longing for beauty, color, and music; also a new generation of playgoers, who were bored by Brahm's drab naturalism. Thus, it became the mission of Max Reinhardt to restore to the theatre its forgotten glamor and magic. Brahm had started out as a scholar, but Reinhardt came from Austria and had in his blood all the elements of the baroque theatre. He created

*MAX REINHARDT*

CULVER SERVICE

an impressionistic style of colorful brilliance. His task was greatly facilitated by certain discoveries which the Swiss designer, Adolphe Appia, had made in Bayreuth, where he became disappointed by the representational, realistic production style which Richard Wagner had adopted. But while Reinhardt never subscribed to Appia's theory of an abstract plastic setting, he shared Appia's belief in the expressive potentialities of light. Another symbolist designer and director, Gordon Craig, likewise revolted against the naturalistic theatre and tried, more successfully in theory than in practice, to translate the spiritual demands of poetic drama into scenic values. Craig, too, had the highest regard for light as the greatest painter of scenes. But while Craig showed little interest in the actor, in Reinhardt's theatre the actor always reigned supreme. Reinhardt directed in circus arenas and market squares, in churches and imperial ballrooms; he made theatre for thousands and for the few invited guests of a dinner party. But he treated his spectators always as participants in a festival. Brahm had been a literary director; Reinhardt often ran into the danger of overemphasizing the scenic elements at the expense of the literary values.

**Expressionism and Constructivism.** After World War I, Reinhardt had the feeling that Berlin no longer understood him. New directors with new styles were taking the capital by storm. One of them was Leopold Jessner, who had taken over the Prussian State Theatre in 1919. Jessner did away with illusionistic scenery, on which Reinhardt had relied. He rediscovered the stage space and found new possibilities for the physical play of the actor's body and the arrangement of groups. In almost all of his productions stairs were very much in evidence, the so-called *Jessner-Treppen* style, which in combination with neutral practicable platforms served as foundation for the burning dynamic intensity of Jessner's actors. Jessner was the chief exponent of the expressionistic style of production. Despite the temptation of a politically aroused time, Jessner never succumbed to the lure of political agitation. Erwin Piscator's theatre on the other hand, had its very starting point in the conscious propagation of the class-struggle theme. Like Jessner's, Piscator's stage was a functional acting platform. As a rule, Piscator's scenery consisted of a skeleton frame in the style of Russian constructivism. He used mechanical devices (motion pictures, globe segments, the treadmill) excessively, although he was serious hampered by the technical inadequancy of his Nollendorfplatz Theater. Walter Gropius' designs for an ideal Piscator theatre (*Totaltheater*) remained in the blueprint stage.

**American Stars, Manager, and National Schemes.** The American theatre of the nineteenth century was ruled by the star system. The first English stars to appear in America were representatives of the romantic school of acting, such as George F. Cooke, Edmund Kean, and Junius Brutus Booth. Next came William Charles Macready, who added domestic touches and realistic by-play to the romantic background. The Macready fever coincided with the emergence of the Philadelphian, Edwin Forrest, the successful rival of Macready. Soon after, other native stars were able to hold their own against the transatlantic guests—the great tragic actress Charlotte Cushman, Joseph Jefferson III (*Rip van Winkle*), and Edwin Booth, America's greatest actor, who had a position similar to that of Henry Irving in England. New managers arose, who built new theatres and had new ideas about stage direction. In this group belong James William Wallack and Lester Wallack, Laura Keene (the American Madame Vestris), Edwin Booth, Augustin Daly, and the great pioneer Steele MacKaye. No other American manager and stage director, however, commanded greater attention than the showman David Belasco, whose stage and, above all, lighting effects became the talk of the town after 1902, when he opened the remodeled Republic Theatre in New York. The wish to have a theatre of his own was chiefly prompted by the fact that in 1896 a group of sixteen theatre men had formed what became known as the Theatrical Syndicate. This trust controlled the leading theatres all over the country and dictated their terms to the producers, playwrights, and actors. In 1911, the syndicate was finally broken and Belasco must be given credit for this outcome of the struggle against monopoly. Belasco's photographic realism had lost its appeal by the end of World War I, when Arthur Hopkins and Robert Edmond Jones joined forces for a theatre of imagination against Belasco's illusionistic tricks. The greatest impetus which the American postwar theatre received came from experimental co-operatives, such as the Provincetown Players, the Washington Square Players, the Theatre Guild, and the Group Theater. In order to help unemployed artists, the Federal Government, under the Works Progress Administration, asked Congress to subsidize, among the other arts, the theatre. The Federal Theater Project (1935-1939) had potentialities of becoming the basis of a national theatre, but was not given the time to develop from a sociological into an artistic institution. In 1935, a group of drama-minded citizens obtained from Congress a charter for the founding of The American National Theatre and Academy (ANTA) which, having been rather dormant for several years, after World War II sponsored performances of new plays in its Experimental Theatre. The community and university theatres of America are represented in the National Theater Conference, an organization which functions as a stimulus for theatrical amateur activities throughout the nation. *See also* COSTUMES; PLAYHOUSES; STAGE.

B. Sm.

*JOHN AUGUSTIN DALY*

CULVER SERVICE

**THEATRICAL AND FESTIVE MASKS,** two of the best known types of masks worn by man. Varying in size from great headpieces to tiny dominos, or half masks, they have been used in dramatic presentations and on festive occasions for centuries.

**Theatrical Masks.** *Greece.* The theatrical mask was used by the Greeks as an essential part of their theatrical entertainments. Just as they were the first to have a theatre for public performances, so were the Greeks the first to use the mask as an important adjunct to a completely theatrical

presentation. The more-than-life-sized masks they used completely covered the head, and had front and side hair attached. They were made of painted canvas with openings for the eyes and the mouth.

The Greek theatrical mask served a three-fold purpose. Since only three male speaking actors were permitted on the Greek stage, the use of a mask permitted each one of the three to double or triple the number of roles he could assume in one play. It enabled him to play female parts, to appear in various stages of manhood, and to sustain and intensify extreme characterizations when the role demanded them. The second function was to help the spectators to recognize characters more easily, for the open theatre was vast, even larger than some of our modern stadiums, and the spectators, of which there were often tens of thousands, were necessarily far removed from the stage. A definitely characterized and familiar mask, such as one of tragedy or comedy, helped to identify the character, even when seen from a great distance. A third purpose of the mask was to amplify the voice; the mouth was equipped with a brass device similar to a trumpet which projected the words spoken by the actor to the farthest reaches of the theatre.

Some use of the theatrical mask was made by the Romans, but with the growth of Christianity it was labeled pagan and fell into disuse.

COURTESY OF THE METROPOLITAN MUSEUM OF ART

*Japanese Nô masks made by Iwao Kongow.* (Left) *Male;* (Right) *Female.*

*Japan.* The theatrical mask has been used in Japan since the seventh or eighth centuries. Its use in *Bu-gaku,* or court masked dances, is said to have been introduced from China. These functions, performed by nobles in palaces and temples, called for the use of large and elaborate masks. They were the forerunner of the *Nô* plays, a form of drama which came into being about the fourteenth century and is in existence, unchanged, today.

The *Nô* plays, of which 210 are still in existence, are short, lyrical tales based on Japanese religious folklore, with which practically all Japanese are familiar. At first presented only by nobles, as were the court dances, for members of their own class, they eventually became a cherished national pastime. Only males are allowed to appear in them and the actors' costumes are carefully prescribed, as are the masks worn by the principals. Because of this, the audiences instantly recognize the characters as they appear. About 120 named varieties of masks are used in the *Nô* dramas and are classified in five types: old person, male, female, god or goddess, and devil or goblin. These masks cover only the face but head-dresses are generally worn with them. They are made of wood which is carved, given a coating of plaster, and then lacquered. Some specimens, still in use, are of great antiquity and are highly valued for their sculptural qualities. The subtlety and refinement of the modeling in the *Nô* masks, and their infinite variety, demonstrate the great ability of the Japanese artists to observe and reproduce the wide range of human facial expression as it typifies the traditional characters of their folklore. It is said of the masks, in fact, that they appear to change in expression when seen in movement on the stage.

*Modern.* Theatrical masks are seldom seen in contemporary dramatic productions. From time to time they have appeared, as they did in the nineteen-twenties, when the talented maker of masks, W. T. Benda, succeeded in reviving them for use in drama, dance, and pantomime. The followers of E. Gordon Craig, the stage designer, have shared his enthusiasm for masks, and they were part of such productions as *Oedipus Rex* and *The Great God Brown,* where they were used to suggest the alter ego of an individual. On the whole, however, the appearance of the mask as an adjunct to present-day theatrical presentations is so isolated that it must be concluded that it is no longer vitally needed in the theatre.

**Festive Masks.** The festive mask, made for traditional holidays, is the most widely used descendant of the ceremonial and theatrical masks. Its history, too, is long. In Siam, Java, and Burma, and all through the Orient, the religious mask gradually lost its early meaning and frequently appeared only as an elaborate piece of decoration. Although morality and miracle plays made some use of religious masks in medieval Europe, a more conspicuous use of them was made in such seasonal festivals as the "Feast of Fools" and "The Boy Bishop," which were dominated by an almost pagan spirit of revelry. These and similar festivals were eventually banned by the Church in the fifteenth century.

The Commedia dell'arte flourished in Italy from the fourteenth century to the seventeenth and produced the still-famous masked characters of Harlequin, Pulcinella, and other classic figures. While the mask was a featured part of these improvised plays, its dramatic use was superficial in nature. However, the domino half-mask and the masquerade balls, which are still part of our festive occasions, are derived from this source.

The comedy theatres of France adopted the manners of the Commedia dell'arte and used the mask in many of their sophisticated comedies and their pantomimes. Pierrot and Pierrette became the counterparts of Harlequin and Pulcinella; their vogue, and also that of the mask and masquerade, persisted in France, as it did in Italy, throughout the eighteenth century. Its penetration into social modes and manners was marked by the liberties in human behavior

*SWISS CARNIVAL MASK*

COURTESY OF THE BROOKLYN MUSEUM

during traditional holidays that have long been indulged in by wearers of masks.

Swiss carnival masks, used in connection with certain of their festive seasons, are lively and humorous. Deft characterizations and an ingenious and interesting use of materials make these masks among the most expressive in contemporary use.

Another present-day use of the festive mask is seen each year in New Orleans during the Mardi Gras celebration, which reaches its climax on Shrove Tuesday, the day before Ash Wednesday, the beginning of Lent. The origin of this Shrove Tuesday festivity is somewhat obscure, but masked parades have for a long time been one of its most important features.

On the whole, the children of today are the most ardent wearers of the festive mask. Christmas, Thanksgiving, Hallowe'en, animal, and character masks are a regular part of their little celebrations. Wearing these masks, the children, even as their primitive ancestors, lose their identities and take on those represented by the masks they wear. *See also* RELIGIOUS MASKS. O. L. R.

**THEBAID, THE** [thi'beid], an epic poem by Publius Papinius Statius, in ten thousand hexameters and twelve books. Derived from the popular Greek story, the *Thebaid* describes the rivalry of the brothers Polyneices and Eteocles for the throne of Thebes. Exiled by his brother, Polyneices enlists allies at Argos, but Thebes is successfully defended from his attack and all of Polyneices' allies are killed. In fulfillment of the curse of their father Oedipus, Polyneices and Eteocles then proceed to kill each other in single combat. Creon assumes the throne and prohibits the burial of Polyneices and other invaders. Jocasta, Oedipus' mother and wife, stabs herself, and Oedipus is dissuaded from suicide and saved from exile only by the intercession of his daughter Antigone. G. McL. H.

**THEBES** [thi'bz], the best-known archaeological site in the Upper Nile Valley, is situated on the banks of the Nile River about 300 mi. south of Cairo. The name Thebes, first known from the *Iliad,* was given the city by the Greeks, possibly because, like Greek Thebes, the city was renowned for its gates. Its Egyptian name was Waset. The site of a part of ancient Thebes is occupied today by Luxor, with 24,118 inhabitants, and Karnak, with 10,865, both on the east bank of the Nile, but ancient Thebes also included a large area on the low land of the west bank, extending up into the foothills, which was mostly devoted to tombs and funerary temples.

During the Old Kingdom (c. 2850-c. 2052 B.C.), Thebes was an inconspicuous provincial capital, ruled by semi-independent princelings who are represented now only by a few rock-cut graves. After an interim of disturbances, their successors began a struggle for the unification of Egypt and finally brought the country under the House of Thebes in the Middle Kingdom (c. 2052-c.1778 B.C.), which marked the beginning of Theban prosperity. Although the great temple-building activity of the New Kingdom has obscured most of the original buildings of this period on the east bank, on the west bank the tombs of some of the rulers, notably that of Mentuhotep II of the Eleventh Dynasty (c. 2052-c.1991 B.C.) at Deir el-Bahri, are still to be seen. During part of the Middle Kingdom, the capital was shifted north to Memphis for administrative reasons, but the kings were still of Theban origin. Toward the end of the Middle Kingdom, when internal strife impaired the unity of the country, the kings of the Thirteenth Dynasty re-established their residence at Thebes. Some modest rock-cut tombs were laid out for them, and inscriptions record their donations to the temple of Amen at Karnak.

Thebes stagnated during the foreign rule of the Hyksos (c. 1670-c. 1570 B.C.), a people of disputed origin from Western Asia, but it was from Thebes that the war to drive out the Hyksos was successfully undertaken. Ahmosis, the first king of the Eighteenth Dynasty (c. 1570-c. 1345 B.C.) finally defeated the invaders, but it was his older brother, Kamose, the last king of the Seventeenth Dynasty, who laid the foundations for this defeat by consolidating Upper Egypt. The royal cemetery of the Seventeenth Dynasty had already been plundered in ancient times, yet some of the splendid funerary equipment has survived; elaborately wrought weapons decorated with inlay work were especially common in tombs of this period.

With the Eighteenth Dynasty, the New Kingdom (c. 1610-715 B.C.) begins, a period of tremendous prosperity for Thebes and its chief god Amen and the Golden Age of Egypt as well as Thebes. It remained for many centuries the chosen residence of the pharaohs and the treasure house for the rich tribute garnered from conquered lands. The wealth of Amen doubled and redoubled, and the power and influence of his priests, who numbered some of the foremost men of Egypt, grew with their wealth.

The great temple structures which rise on the east bank of the Nile are, outside of the pyramids, the most imposing remains in Egypt today. The temple of Amen at Luxor, like its greater counterpart at Karnak, was not built at any one time, as is evident from its plan, which includes a complex and reduplicated series of pylons, colonnaded forecourts, and hypostyle halls. This temple was begun by Amenhotep III (c. 1413-c. 1377 B.C.) on the site of an earlier sanctuary and was considerably altered and enlarged in later years, particularly by Rameses II (c. 1301-c. 1234 B.C.), the greatest builder of all the pharaohs, who added a large new colonnaded court and flanked the entrance with enormous pylons, in front of which stood colossal statues of himself. One of the better-preserved statues is approximately 55 ft. high, which gives an indication of the vast scale of the temple. In Christian times, part of the temple was used as a church, and at present a tiny mosque still stands in its northern section.

At Karnak, the temples to Mut, Amen's spouse, his son Khons, and the war god Mont, impressive as they are, are dwarfed by the Great Temple of Amen which, as it stands today, is over a fifth of a mile long. The core of the temple goes back at least as far as the Twelfth Dynasty of the Middle Kingdom, and beginning with Thutmose I, early in the New Kingdom, it was constantly remodelled and enlarged by the addition of a succession of courts, colonnaded halls, and pylon after pylon. Of the individual parts of the temple, the great hypostyle hall of Rameses II is perhaps most notable; its size is such that the entire cathedral of Notre Dame could be placed within it. These temples are all embellished, both without and within, with reliefs and inscriptions, most of them relating to the accomplishments of the various pharaohs.

The tombs of these pharaohs, with few exceptions, were placed in the "Valley of the Kings," a spot more difficult of access than the earlier cemeteries which had been so consistently plundered. Since the valley did not offer enough space for the increasingly grandiose funerary temples, a line of majestic mortuary structures began to rise along the west bank. An exception is the great terrace-temple of

EWING GALLOWAY

*REMAINS OF THE NORTHERN PART OF THE HYPOSTYLE HALL OF THE RAMESSEUM AT QURNA IN ANCIENT THEBES*

Queen Hatshepsut (c. 1501-c.1480 B.C.) at Deir el-Bahri, next to that of Hatshepsut's Middle Kingdom predecessor Mentuhotep.

The court of Amenhotep III (c. 1413-c. 1377 B.C.) in the latter part of the Eighteenth Dynasty surpassed in luxury anything previously seen in Egypt; his funerary temple is still marked by two of the colossi which fronted it—the "Colossi of Memnon" so much admired by Roman travelers, many of whom inscribed the record of their visits on the statues themselves. Of other funerary temples along the west bank, the best-known is the so-called Ramesseum of Rameses II.

Under Amenhotep IV (Ikhnaton), the capital was temporarily removed to Amarna. It was returned to Thebes by his son-in-law Tutankhamen, the discovery (in 1922) of whose unrifled tomb in the Valley of the Kings stirred the world. All the funerary equipment of Tutankhamen's tomb is preserved, including the king's mummy in its golden coffin, and its wealth suggests the magnificence of the lost offerings from the larger and more important royal tombs near by.

With the rise of the Twenty-Sixth Dynasty (Saïte period, 663-525 B.C.), the political center of Egypt again shifted north, and the ancient capital lost its political significance; but it remained an important religious center, and after the conquest of Egypt by Alexander the Great it momentarily recovered its independence. The earlier Ptolemies continued to increase the size and beauty of the temples and even to build anew, but the last Theban revolt ended in the destruction of Thebes as a city about 30 B.C. Strabo (24 B.C.) found there only scattered villages, but until late Imperial times the magnificent ruins attracted numbers of sightseers, as indeed they do today, while with the rise of Christianity the temples and tombs became churches and monasteries devoted to the worship of the new God. *See also* EGYPTIAN ARCHITECTURE, ANCIENT; KARNAK, TEMPLES OF; LUXOR.

J. H. Y.

**THEBES** (Gr. Thívai), a city in Boeotia, in central Greece. The town of Thebes lies in well-watered and fertile rolling country which has been inhabited since prehistoric times. Thebes was reportedly founded by the legendary Cadmus, a Phoenician who introduced the alphabet to the Greeks. The story may preserve a rememberance of the writing of Mycenaean times, for Thebes was the principal Mycenaean city in Central Greece. She does not appear in the Catalogue of Ships in the *Iliad,* having been destroyed by the Argives, according to tradition, but in the sagas of the Heroic Age the Theban cycle was second only to the Homeric.

In Classical times, Thebes was the foremost city of Boeotia, normally dominating the loosely organized Boeotian League. She was one of the "Medizing" Greek states in the Persian Wars and temporarily lost this dominance as a result. During most of the fifth century she was engaged in intermittent wars of rivalry with Athens, but after the decline of Athenian power at the end of the Peloponnesian War she occasionally allied herself with Athens against the Spartans. For a brief period in the early fourth century, Thebes, at the head of the Boeotian League, was the chief city-state in Greece. With Epaminondas as her leader, she was at the height of her power when she defeated the Spartans at the Battle of Leuctra in 371 B.C. Epaminondas was killed at the Battle of Mantinea in 362, and thereafter Theban power quickly declined.

Philip of Macedon was educated at Thebes, and this training stood him in good stead in his aggression against the Greek city-states. Thebes, together with Athens, was disastrously defeated by Philip at the Battle of Chaeronea in 338 B.C., and her famous "Sacred Band" was annihilated. Her revolt against Alexander in 335 caused him to raze the city, sparing only the temples and the house of the much earlier Theban poet, Pindar. Although rebuilt by Cassander not long afterward, Thebes never again regained her importance in antiquity.

Parts of ancient Thebes have been excavated, particularly the temple of Ismenian Apollo and areas of the Mycenaean city and palace.

During the Middle Ages, Thebes was an important center for silk-making and dyeing and was the capital of the

Frankish Duchy of Athens. Under Turkish occupation, she again sank into an obscurity from which she did not emerge until modern times. Pop. 1951, 12,582. *See also* CADMUS; EPAMINONDAS; SEVEN AGAINST THEBES, THE. J. H. Y.

**THECLA OF ICONIUM, ST.** [thē'klə] (first century), Christian saint, "protomartyr among women and equal to the Apostles," is known from the apocryphal *Acts of Paul and Thecla.* Converted by St. Paul, she dedicated herself to virginity. Condemned to death for her faith, she was miraculously preserved and retired to Seleucia. Her feast is September 23. W. C.

**THE DALLES** [thə dæ'lz], a city in northern Oregon, the county seat of Wasco Co., 70 mi. east of Portland, situated on the south bank of the Columbia River, at the mouth of Mill Creek. The completion of the Bonneville Dam and the locks make the city a Pacific Coast port with a 200-mi. waterway to the ocean. Pine timber is abundant in the region, and 11 mi. eastward up the Columbia are Celilo Falls where the Indians fish during the salmon run. The Dalles is the trading center for an agricultural area. Lewis and Clark visited the site in 1805. The first white settlement in 1838 was abandoned after the Whitman Mission massacre in 1847. Fort Lee was built in 1849, and a town grew around it. Fort Dalles received its city charter in 1854 and shortly changed the name to Dalles City, but the Post Office Department called it The Dalles, which was adopted by the city. The city is governed by a council and manager. Points of interest include the Federal Building, the county courthouse, the parade ground of old Fort Dalles, and a mint which was erected in 1868 by the Federal Government but never used to coin money. The Union Pacific Railroad and the United Air Lines serve the city. Industrial establishments comprise railroad shops, flour and lumber mills, and salmon fisheries. Pop. 1950, 7,676.

**THE HAGUE.** *See* HAGUE, THE.

**THEISM,** belief in God; specifically, belief in one eternal, personal God, who is both immanent and transcendent. God's immanence means that he is in the world of persons and things as their creative ground and sustainer. His transcendence means that his personality and purposes include more than is evident in the world. Theism is contrasted with polytheism, which is the belief in many gods; with deism, which excludes God's immanence; and with pantheism, which excludes God's transcendence. Theism is the opposite of atheism. The term theism is frequently used as a synonym for natural theology, in contrast with revealed theology.

**History.** The word theism was used as early as 1678. Originally synonymous with deism, it has come to have its distinctive meaning since the close of the eighteenth century. Monotheistic belief arises in the development of most of the higher religions, often following a polytheistic stage. This rise may be observed in religions of China, India, Egypt, Greece, and Rome, as well as in the Judaeo-Christian religion. The theistic God is not only an object of religious worship, but also, in some systems of philosophy, a principle of philosophical thought. The number of such systems includes those of Plato, Aristotle, Ramanuja, St. Thomas Aquinas, Locke, Berkeley, Descartes, Kant (a modified theist), Lotze, modern neoscholastics, personalists, and religious realists. H. N. Wieman and certain other philosophers of the second quarter of the twentieth century who reject the personality of God speak of themselves as naturalistic theists.

**Theistic Arguments.** Many arguments intended to prove the existence of God have been advanced in the course of history, eight of them sufficiently well known to warrant special mention. (1) The cosmological argument holds that the world as dependent and conditioned requires an independent and unconditioned first cause. (2) The teleological argument holds that the signs of adaptation and purpose in the world require God as an original purposer. (3) The ontological argument holds that the very idea of God as a perfect being implies his existence, either because perfection includes and requires existence (Anselm's view), or because an idea of perfection requires a perfect cause (Descartes' view). St. Thomas did not accept the ontological argument, and Kant subjected the cosmological and teleological arguments to searching criticism. (4) Kant's moral argument holds that moral law presupposes God as ground of the moral order. This moral argument and the four which follow have been specially emphasized in post-Kantian times. (5) The axiological argument holds that the total experience of value—logical, moral, aesthetic, and religious—points to God as a personal source of value. (6) The argument from interaction holds that the causal interaction of things presupposes a unitary and personal ground of interaction. (7) The idealistic or personalistic argument holds that conscious personality is inexplicable as a result of unconscious forces, and requires a cosmic person as its explanation. (8) The argument from religious experience holds that religious (particularly mystical) experience is a direct awareness of God or of co-operation with him.

**Theistic Belief in the Twentieth Century.** The development of science, the evolutionary theory, naturalistic philosophies, and positivism, combined with increasing secularism and the pessimism aroused by World Wars I and II, have produced a climate of opinion unfavorable to theistic belief. Prominent thinkers like Bertrand Russell, John Dewey, and George Santayana have rejected traditional theism. Positivism, with its rejection of all propositions that cannot be expressed in a physicalistic language and verified by the senses, is hostile to theistic belief. But no essentially new antitheistic arguments have arisen; and many physical and biological scientists, as well as a number of eminent philosophers, including A. N. Whitehead, W. E. Hocking, James Ward, B. P. Bowne, and J. E. Boodin, have found some form of theism acceptable. *See also* ANTHROPOMORPHISM; ATHEISM; DEISM; PANTHEISM; POLYTHEISM.

E. S. B.

**THEME,** in music, a sequence of tones that serves as the basic idea or subject of all or part of a musical composition, filling the same function as the text of a sermon or the subject of a debate. Broadly speaking, the theme belongs to purely instrumental music, the melody to vocal music. The differences between the two, which are not always distinct, therefore arise from the differences between their respective media: a melody tends to be a well-rounded, self-contained unity so bound by the limitations of the human voice as to be "singable"; a theme is often short, lacking a clear-cut physiognomy, entailing leaps and rapid progressions playable only on an instrument, and existing more as a potentiality for development than as an entity. More specifically, the theme includes the brief figure or motive that abounds in Baroque music, the well-defined subject of the fugue, and the underlying ideas in sonata form.

Between 1600 and 1900, themes became increasingly tangible and more melodic in shape and character, and their significance in musical form increased proportionately. The Classical theme is sometimes only a germinal idea as in the

"fate" motive of Beethoven's Fifth Symphony, but it ordinarily differs from the Baroque motive in both its completeness and its contrasts within itself. During the Romantic period there was wide variation in theme, from the brusque, angular themes of Richard Strauss to the leisurely, song-like melodies of Schubert, but many modern composers have reverted to the motival theme of the Baroque era. W. S. N.

**THEMIS** [thi′mɪs], in Greek mythology, the personification of justice, who presided over the assemblies of gods and men. She was a Titaness, the daughter of Uranus and Gaea, and was beloved by Zeus, to whom she bore the Hours and the Fates. *See also* TITANS. G. E. D.

**THEMISTOCLES** [thəmɪ′stokliz] (c. 514-c. 450 B.C.), Athenian statesman. The son of an Athenian father and a foreign mother, Themistocles attained political leadership at Athens through talent alone. His influence was always resented by the Athenian aristocrats, who had reigned supreme in the councils of Athens before his time. If it had not been for the crisis precipitated by the Persian invasions, birth instead of worth might have continued to be the criterion for high office at Athens.

**Triumph over Aristides.** The fundamental policy of Themistocles was based on his theory that Athens must become a sea instead of a land power. It is believed that as early as 493 B.C., when he held his first archonship, he began the building of a naval base at Piraeus. Then, in the decade following the Battle of Marathon in 490 B.C., Themistocles carried on his campaign for a big navy, against the conservative followers of Aristides, who favored a large army. The question was finally decided in 483 B.C. when Aristides was ostracized. In the following year, Themistocles was able to persuade the Athenians that they should use the new revenues from the silver mines at Laurium to build a fleet of two hundred triremes to meet the inevitable invasion which Xerxes was preparing.

**Victory over Persians.** When the Persian invasion began in 480 B.C., it was Themistocles who forced the Greeks to make a stand at Salamis and fight it out with the Persian fleet there instead of withdrawing to the Peloponnesos, as the Spartans and many others wished to do. As the Greeks wavered and considered fleeing from Salamis before they could be trapped by the Persian fleet, Themistocles sent a message to Xerxes that the Greeks were planning to flee and that the Persians would do well to attack immediately. As a result, the Persians were drawn into a narrow, unfavorable strait where the lighter, swifter Greek ships could outmaneuver them. This was the essential strategy of the great victory at Salamis in 480 B.C.

**Decline and Exile.** When Athens was reoccupied and the Athenians wished to rebuild their walls, they were opposed by the Spartans, who wanted to keep Athens an open, undefended city. Themistocles then went to Sparta and kept the Spartans occupied with negotiations while the Athenians rebuilt their walls. When the Spartans sent envoys to Athens to discover what the Athenians were doing, they were held as hostages for the safe return of Themistocles. Themistocles was probably responsible for the creation of the Delian League, which placed Athens at the head of a large naval force and helped to counterbalance the land strength of Sparta and the Peloponnesian League. After the formation of the Delian League in 477 B.C., political influence at Athens passed to the great military and conservative leader, Cimon, and the power of Themistocles waned. He was ostracised in 471 and soon thereafter was involved in the scandal which brought the downfall of the Spartan general Pausanias. Hunted as a traitor who had held treasonable correspondence with the Persians, Themistocles at last fled to Persia about 464 and was well received by Artaxerxes, who had just come

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to the Persian throne. Themistocles died in Asia Minor, perhaps as a suicide, about 450 B.C. T. B. J.

**THEOBALD** or **TEDBALDUS** [thi′obɔld, tɪ′bəld; tɛdbɔ′ldəs] (d. 1161), archbishop of Canterbury, was of Norman descent. He became a Benedictine monk of the abbey of Bec sometime between 1093 and 1124, was made prior in 1127, and abbot in 1137. In 1138 he was elected archbishop of Canterbury and consecrated the following year. In the long struggle between King Stephen and the Empress Matilda, Theobald loyally adhered to the King, whom he crowned, though his sympathies lay with the Angevin Party. He was for several years involved in difficulties as a result of the appointment of the Bishop of Winchester as papal legate, causing a division of authority in the Church of England. Although the latter's commission expired with the death of Innocent II in 1143, Theobald did not receive legatine authority until 1150. Despite Stephen's interdict, he attended the council of bishops summoned by Eugenius III at Reims in 1148, and there saved the King from excommunication. In 1152, acting on papal authority, he refused to crown Eustace, the King's son, and as a consequence was forced into exile, but was recalled by Stephen at the end of the year. When Henry of Anjou was in England in 1153, Theobald reconciled him to the King, making possible the treaty of Wallingford (1153), which ended the civil war. On Stephen's death the following year, he crowned Henry II. Theobald attached to his household many young men of outstanding talent, chief among whom were Roger de Pont l'Evêque, Thomas à Becket, and John of Salisbury. He was also the first to introduce the study of civil law into England, and founded a law school at Canterbury, where the famous Italian jurist Vacarius lectured on Roman law. Theobald died on Apr. 18, 1161. C. W. D.

**THEOBALD, LEWIS** [thi′obɔld; tɪ′bəld] (1688-1744), English dramatist, translator, and editor, was born in the early part of April 1688 at Sittingbourne, Kent. He early made translations from the works of Classical writers: Plato (1713), Sophocles (1714-1715), *The Odyssey* (1716), and Aeschylus (unpublished). He also wrote for the stage, bring-

ing out tragedies, including an adaptation of Shakespeare's *Richard II* (1719), and many pantomimic and operatic pieces. His major work, however, was his editing of Shakespeare. In 1726 he published *Shakespeare Restored,* a criticism and correction of Alexander Pope's edition of Shakespeare (1725), and in 1734 printed his own edition of Shakespeare in seven volumes, a work which went through three editions between 1734 and 1757. Theobald's importance as an editor of Shakespeare lay in his good sense, his application of the spirit and method of modern scholarship to Shakespearean problems, and his elevation of English literature to more serious study by giving it the careful, scholarly attention which had previously been accorded Classical authors. Theobald died in London, Sept. 18, 1744. E. L. A.

**THEOCRACY** [thiɒ'krəsi], literally "rule by God," a term applied to any state the government of which is devoted primarily to the achievement of religious ends or is markedly subject to an organized priesthood. The term includes forms in which a supernatural being is conceived directly to exercise sovereign power, as well as those in which divine power is wielded through human intermediaries. Common among Oriental monarchies, theocratic characteristics were displayed in the Papal States, in Calvinist Geneva, and in America in Puritan Massachusetts, Mormon Utah, and Paraguay. F. V. C.

**THEOCRITUS** [thiɒ'krɪtəs] (fl. third century B.C.), Greek bucolic poet, a younger contemporary of Callimachus, was born at Syracuse near the end of the fourth century B.C. We learn from an epigram that his parents were Praxagoras and Philina. Early in his career he lived in Cos, an island

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with which his mother's family may have had some connection. In Cos he met the poets Philetas and Asclepiades, among others, and probably began a lifelong friendship with the doctor-poet Nicias. Returning to Sicily about 280 B.C., he sought unsuccessfully the patronage of Hiero, tyrant of Syracuse. Ptolemy Philadelphus of Egypt proved more receptive, and from 274 to 270 Theocritus enjoyed the hospitality of Alexandria. He apparently returned to Cos for some years and may have visited Miletus, the home of Nicias. His best period must have been 275-260 B.C., and he must have reached a reasonably old age, since he speaks of gray hairs in Idyll xxx and Statius refers to him as *"Siculus senex"* ("the elderly Sicilian"). This scanty account is largely derived from Theocritus' own writings, since there is little evidence that even the ancients knew much about the poet's life. The surviving body of works traditionally ascribed to Theocritus consists of thirty idylls (short poems) and more than twenty epigrams. The authenticity of the epigrams is difficult to estimate though many are worthy of Theocritus; of the idylls only twenty-two can fairly be regarded as genuine. The catalogue of lost works, which includes hymns, heroines, dirges, elegies, and iambics, bears testimony to the poet's versatility.

Theocritus is generally regarded as primarily a poet of pastoral life, but only one-third of the preserved collection of his idylls consists of pastoral poems. Such poems are, in fact, only part of a larger category of dramatic pictures of both country and city life, sometimes in monologue form, sometimes in dialogue. A regular feature of the dramatic poems is the inserted song, whether assigned to one or to alternating voices. Such songs may be found in the *Thyrsis, Serenade, Herdsmen, Goatherd's Song, Harvest Home,* and *Reapers,* all poems of country life; they enter into city scenes in the *Spellbinders* and the *Syracusan Women.*

Independent lyrics and poems of a similar character form a second group of idylls. Two love poems, Aeolic in dialect and meter, owe their inspiration to the lyric tradition of Lesbos; a third Aeolic poem was sent with Theocritus' gift of a distaff to the wife of Nicias. Another love poem, *The Beloved,* is written in the Ionian dialect instead of Theocritus' usual Doric. Two court poems, the *Graces,* addressed to Hiero, and the *Panegyric of Ptolemy* add little to the writer's reputation.

The third group of idylls is composed of short poems treating epic subjects in various fashions. The *Cyclops* and *Hylas* are addressed to Nicias; both consist of mythological love stories within a letter-like framework. The former tells how Polyphemus soothed his love pangs by singing to his beloved Galatea; the second suggests that even the strongest of men, Heracles, could be overcome by love. The *Wedding Song of Helen* may have been inspired partly by Stesichorus, partly by Sappho's *Wedding Songs;* the *Hymn to the Dioscuri,* a typically Alexandrian modification of an old form, is half dramatic, half narrative; the *Infant Heracles* is notable for its picture of domesticity; and *Heracles the Lion-slayer* seems to be an incomplete sketch made up of three unrelated episodes.

Theocritus' pastoral poems, rooted in the Sicilian songs he knew so well, have a freshness and vigor—in spite of their artificial form—which all his successors lack; the vividness of such dramatic scenes as *Syracusan Women at Adonis' Festival* owes much to the Sicilian tradition of dramatic representation of humble life established by Epicharmus and Sophron. The example of Stesichorus may have aided Theocritus in his Hellenistic modifications of epic themes. The frigid hand of Alexandria hardly touched him except in his *Panegyric of Ptolemy.* At his best he offers a unique combination of the nature lover and the artist, of realism and convention; at his worst his sympathetic humor and sense of aesthetic propriety give him gracefulness.

The bucolic tradition which Theocritus established owes much to his influence, direct or indirect. Moschus and Bion followed him in Greek; in Latin Vergil's indebtedness is apparent, and Vergil passed on the tradition to Calpurnius and Nemesianus. In the sixteenth century, through original text, translation, and adaptation, Theocritus' influence began to spread over western Europe and England, and has persisted to influence American writers as well. C. M. D.

**THEODORA** (c. 508-548), wife of the Roman Emperor Justinian. Most of the information now available about Theodora comes from a hostile source, the historian Procopius. Theodora, whose father is said to have been a bear-keeper at the Hippodrome, first rose to fame as an actress who had more personality than talent. Like many other

professional entertainers of antiquity, Theodora was a courtesan. In this capacity she attracted the attention of Justinian. They were married about A.D. 523, and when Justinian became emperor in 527 Theodora sat beside him on the throne as empress. In this exalted position she strove for respectability. She took a great interest in charities and established an institution for fallen women; she also extolled the virtues of marriage and arranged a number of matrimonial alliances at the court. In the field of imperial affairs, Theodora exercised great influence over Justinian. She is supposed to have determined his policies even to the point of giving orders to his generals. The suppression of the Nika riots of A.D. 532 was the direct result of Theodora's courage and steadfastness at a time when Justinian himself might have jeopardized his throne through lack of a firm policy. Naturally the influence of Theodora was resented by various factions at the court. Her love of Oriental ostentation, as well as her support of the Monophysite sect, offended many people, but her domineering personality alone would have been sufficient to arouse considerable hostility. T. B. J.

**THEODORE** (Rus. Fyodor or Feodor), the name of three tsars of Russia.

**Theodore I** (1557-1598). The son of Ivan IV, the Terrible, and Anastasia Romanovna, Theodore I succeeded his father in 1584. As he was physically and mentally unstable, the real power of government was vested in his brother-in-law, the boyar Boris Godunov, who succeeded to the throne on Theodore's death in 1598. Theodore was the last of the Rurik Dynasty.

**Theodore II** (1589-1605). The son of Boris Godunov, Theodore II was proclaimed tsar on the death of his father, Apr. 13, 1605. On July 10 of the same year he was murdered, as the result of a boyar conspiracy to nip the Godunov Dynasty in the bud.

**Theodore III** (1656-1682). The son of Tsar Alexis I and Maria Miloslavsky, Theodore III Alexeyevich succeeded to the throne at the age of 15 and, until he became of age, ruled under the regency of his elder sister Sophia. His relatives, the Miloslavskys, who clung to the ancient traditions of Russia, on Theodore's accession seized the opportunity to banish the boyar, Matviyeyev, who had attempted to introduce Western ideas. Though an invalid, Theodore was a vigorous monarch and, among other administrative and cultural reforms, abolished one of the worst abuses of the Russian nobility, the *miyestnichestvo,* a system of precedences and privileges among the boyars, according to elaborate and carefully preserved Books of Rank. He also founded an academy at Moscow at which Greek and Latin were taught, as well as Slavonic. On his death, on Apr. 27, 1682, he was succeeded by his brother Ivan V. C. W. D.

**THEODORIC THE GREAT** [thiɒ′dorɪk] (454-526), King of the Ostrogoths, was born in 454 in Pannonia, a Roman province in the region of modern Hungary and Yugoslavia. His father was the Ostrogothic King Theodemir. As a boy Theodoric spent ten years as a hostage at the Byzantine court at Constantinople. He gained his first military experience as a general when the Ostrogoths invaded Moesia and Macedonia in 473. As king of the Ostrogoths and a Byzantine vassal, Theodoric invaded Italy and attacked Odoacer in 488. After defeating Odoacer in 493, Theodoric ruled Italy for thirty-three years until his death in 526. The Italians remembered his reign as a period of peace and prosperity such as the peninsula had not known for over a century. The only unpleasantness occurred when Theodoric, an Aryan, permitted the execution of the Catholics, Symmachus and Boethius. T. B. J.

**THEODOSIUS I** [thi′odo′shiəs] (c. 346-395), called the Great, Roman emperor, was born in Spain about 346, the son of Theodosius, one of Emperor Valentinian's generals who was executed in 376. The younger Theodosius served with his father in Britain in 368 and in 374, and defeated the Sarmatians who had invaded Moesia. After the death of his father he lived in Spain, but was summoned to court by the youthful Emperor Gratian after the death of his colleague, Valens, at the Battle of Adrianople on Aug. 9, 378. Theodosius was invested on Jan. 19, 379, with the Empire of the East, comprised of Thrace, Asia, and Egypt. In 379 he defeated Gothic invaders, receiving their capitulation on Oct. 3, 382; he then made 40,000 of his former enemies *foederati,* and settled them along the borders of the empire. In 383 he had Arcadius, his eldest son, proclaimed Augustus. By the murders of Gratian and his successor, Maximus, Theodosius became in 388 sole head of the empire. In 389 he entered Rome, where he lived for the next three years. Having embraced Christianity and been baptized in 380, he decreed that all his subjects become Christians. He vigorously attacked superstition and idolatry, and promulgated numerous severe edicts against heretics. In 390 he ended a revolt in Thessalonica by a bloody massacre. Soon afterwards, Arbogast, Theodosius' agent in the West, revolted and advanced to the borders of northern Italy. His army under Eugenius almost destroyed Theodosius' troops, but on Sept. 6, 394, Theodosius was completely successful. He went to Rome, had his younger son Honorius proclaimed emperor of the West, and then retired to Milan, where he died on Jan. 17, 395. His empire was divided after his death between his sons, Honorius and Arcadius. Theodosius II (401-450) succeeded his father, Arcadius, in 408 as emperor of the East. The Theodosian Codex of imperial constitutions was completed in 438. He died in 450. T. R. H.

**THEOGNIS** [thiɒ′gnɪs] (sixth century B.C.), Greek elegiac poet, was born at Megara in Greece and probably resided in exile at Megara in Sicily. On the evidence of the political situation reflected in his poems, his chief productive period may be set between 550 and 545 B.C. Of the 1400 lines preserved under his name it is known that some were written by Tyrtaeus, Mimnermus, Solon, and Euenus. These probably constitute a group of independent collections of aristocratic precepts and songs, fairly representative of sixth- and fifth-century elegy. However, the passages addressed to a young friend, Cyrnus, are certainly by Theognis. Uncompromisingly bitter toward the commoners who expelled the aristocrats, and toward those nobles who betrayed their class by marrying into new but wealthy families, Theognis instructs Cyrnus in the behavior of the true aristocrat in politics and in society. The last 160 lines, forming a kind of appendix, consist largely of erotic verse. C. M. D.

**THEOGONY** [thiɒ′goni] (*Genealogy of the Gods*), a Greek didactic poem written by Hesiod (probably eighth century B.C.), which is an attempt to organize into a coherent system the legends concerning the origins of the world, the gods, and their descendants. From Chaos and Earth arose such deities as Night, Day, Heaven, Mountains, Sea, and Sky (Uranus)—that is, the various aspects of Nature—and others, including the Titans and Giants. Uranus remained preeminent until he was overthrown by his son, Cronus, who, with Rhea, established another dynasty. The descend-

ants of Cronus included, among others, Demeter, Hera, Hades, Poseidon, and Zeus. Cronus was replaced by Zeus, who by marriage with various goddesses created the third generation of gods. This account is followed by a list of the goddesses who married mortals and of their children. At some time later than Hesiod, perhaps, there was added the *Eoeae,* a catalogue of women who bore children to gods; apart from a number of scattered fragments, there is preserved only a transitional passage which was put at the end of Hesiod's poem to make the *Theogony* and *Eoeae* a continuous work. *See also* HESIOD. C. M. D.

**THEOLOGICAL EDUCATION,** or training for the religious ministry. This falls into four fields of study among Protestants: (1) theology, the rational explanation of the intellectual content of religion; (2) Biblical literature, including its concomitant study of Greek and Hebrew; (3) Church history, containing the historical and biographical details of the development of the Church and of the leaders in it from its beginning; and (4) practical theology, which includes the preparation and delivery of sermons, the organization and administration of the Church on both a local and national level, the art of ministering to the ill in the role of pastor, and other studies. The Roman Catholic Church makes a somewhat similar division of theological education, but under the following studies: ascetical theology, dogmatic theology, moral theology, mystical theology, natural theology, pastoral theology, and positive theology. In addition to theology, Biblical literature, Church history, and practical theology, studies in Jewish seminaries include such subjects as rabbinics, rabbinical literature, and Hebrew literature (medieval and modern).

The Roman Catholic Church divides its theological education into two parts. The preparatory seminary carries the candidate approximately to completion of Junior college. Then follows the major seminary education, two years being spent in the study of philosophy, and four in theology.

A. W. S.

**THEOLOGY** [thiɒ'loji], the systematic study of God and his relation to man. The word theology is derived from two Greek words, θεός, "God," and λόγος, which may be translated "science." Theology is thus properly defined as the science of God, but it is more adequately described as the science of God and his relation to man.

The word *theologian* was originally used to designate a man whose special task was to exalt the deity. In Greek literature Homer is described as a theologian because he wrote about the gods. Among the Romans the theologian was placed in the class of poet laureate, and it was his task to praise the deified emperor. The early Christians looked upon the theologian as the defender of Christ's deity. John, the author of the book of Revelation, is sometimes called John the Divine, that is, John the theologian, ostensibly because throughout Revelation he exalts Jesus as Lord. Theology, then, was looked upon in early times as a formal act of worship on the part of a writer on religious subjects. In the course of time, *theology* became the accepted technical name for the study of God and his concern for man.

Theology must be distinguished from the science of religion, which is concerned with the fundamental principles at work within man's religious life and is the study of man in worship rather than the study of the object he worships. Theology, on the other hand, is the study of the object of worship, God. In theology, then, God is central and man is considered only as the worshipper of God.

Theology is also to be distinguished from the philosophy of religion. These two disciplines are related to one another in much the same way as are questions and answers. The philosophy of religion asks such questions as the following: Is the universe meaningful? Does it have a purpose? Is the universe friendly toward the religious man? Is God as the supreme being the origin and end of dependent beings? Theology supplies the dogmatic answer to the profoundest questions of religion, replying that God is the first and originating cause, who brings into being all other existing things as dependent creatures, and that God as the supreme being is friendly toward man.

**The Content of Theology.** Within the science of theology the distinction is made between theology proper in the narrow sense and theology as it concerns God's special relation to man. Theology proper is the study of God with respect to his existence, nature, person or persons, purpose, and especially his relation to evil. Theology as including the relations of God to his creatures is divided into the following departments for special study: Anthropology, which is the study of man as to his origin, constitution, and destiny; Christology, which is the study of the person, the natures, and the purpose of Christ; Soteriology, which is the study of the application of salvation as obtained by Christ in his ministry through the operation of the Holy Spirit upon the redeemed individual; Eschatology, which is the study of the end of this present world and the nature of the new heaven and the new earth; Ecclesiology, which is the study of the Church as the divine institution; and Moral Theology, which concerns human acts as related by reason and faith to an ultimate supernatural end. In each one of these special fields the theologian begins with an empirical study of available material in order to discover the place of God in the life of man, God being the central object of study both in theology proper and in its several departments.

Theology recognizes three different ways of coming to a knowledge of God. Reason is the first way. Through his senses man comes into relationship with the physical world, and through his reasoning faculty he infers the existence of nonphysical being as the cause of the physical world. He then infers that God exists as the creator and sustainer of the natural world and that He is the first, necessary cause of all that exists. A theology constructed on this way of knowing God is called natural theology because it draws its data from natural reason. The second way of knowing God is by means of an immediate experience of God, which comes to man in much the same way as does experience of the physical world—not through the five physical senses, but through the so-called "spiritual sense." This spiritual experience is referred to under a variety of names, such as *feeling, intuition,* and *insight.* Theology constructed on knowledge of this kind is called mysticism. The third way of knowing God is through the compelling action of God, God revealing or disclosing himself to man by this action much as one person compels the attention of another. Theology established on this way of knowing God is called revealed theology; it questions in no way the validity of the other types of knowing, but it insists that a knowledge of God that springs from divine compulsion comes prior to all other knowledge concerning him.

**Christian Theology.** Christian theology differs from other theologies in its emphasis upon the revelation of God in Jesus Christ. According to Christianity, God has encountered men in various ways and at different times, but the unique and final revelation was made in the historic Jesus who lived in Palestine at the time of Pontius Pilate. This revelation is interpreted and attested by the prophets

and apostles in the Scriptures. Whereas other theologies are centered in God, Christian theology is centered in God and in Christ; it is also centered in the Bible, as containing the word of God.

From the very beginning of the history of Christian theology, theologians assumed that the authentic text of Church doctrine was to be found in the canonical writings delivered to the Church by the Apostles. The Church opposed every attempt to set this apostolic legacy aside, and the ecumenical Church of the fourth and fifth centuries accepted without question the apostolic authority. During these years and the centuries following, the Church called her councils to formulate her official doctrines—such as those of the Trinity, the Person and Natures of Christ, Grace and Free Will, and other disputed subjects—with the intention of expressing the teaching of the apostles in the language of the day. The teachings of the Church Fathers were subject to Scriptural verification; furthermore, when these teachings contained contradictions, as Abelard and others found that they sometimes did, the Scriptures were assumed to be an authentic test of the truth of the conflicting statements. The Protestant Reformers insisted that they were in agreement with the Fathers in so far as the latter were in accord with the Scriptures, but they firmly opposed certain practices and doctrines of the Church of their time because they believed them to be not in accord with the Scriptures. The validity of this belief was attacked, in turn, by the theologians of the Counter Reformation.

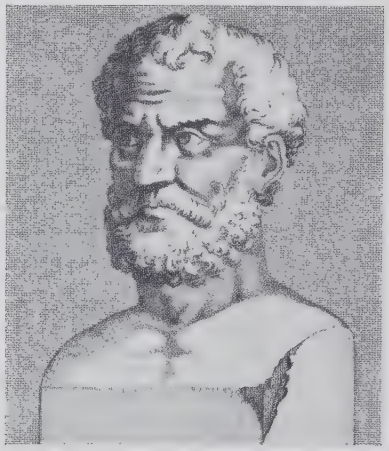
The father of the modern Protestant school of theology, F.E.D. Schleiermacher (1768-1834), under the influence of the scientific method, formulated a new conception of theology within Western Christendom. He substituted the individual's Christian experience for the Apostolic testimony as the source of theology. Man took the place of God at the center of study; psychology supplanted theology; the unchanging Christ gave way to the changing Christian experience. Thus theology was deprived of all objective truth in history. The followers of Schleiermacher were not slow to realize the implications of this conception of theology, and in succeeding generations they reduced Christian theology to an interesting ideology rooted and grounded in Christian culture.

This diversion of modern theology from the traditional genius of Christian theology was of only short duration. Within one hundred years of Schleiermacher's revolt against tradition, Karl Barth in 1919 published the first edition of his commentary on the epistle of Paul to the Romans, in which he urged the Church to turn back to the Scriptures as testifying to the revelation of God in Jesus Christ. Since the appearance of Barth's work there has been a general return on the part of Protestant theologians to the Word of God as the objective revelation of God. Theology must conform to the Word, *the Word* signifying God's encounter with man in the historic Christ. Contemporary trends in the Protestant churches are indicative of the popularity of this conception of Christian theology.

Roman Catholic theologians draw a sharp distinction between positive and speculative theology. Positive theology, thus distinguished, has as its aim to establish clearly which are the truths that God has revealed to man. Speculative theology has as its aim the understanding of revealed truths. A combination of the two is found in the scholastic theology of the Middle Ages, notably in the teachings of St. Thomas Aquinas (1225-1274).

There are in general four ways in which contemporary theologians express the genius of Christian theology. First, there are the traditionalist theologians, who teach that the meaning of the word of God is to be found in the writings of the great ecclesiastical tradition. The Roman Catholics turn primarily to Thomas Aquinas as a representative of this tradition; the Protestants hold the great Reformers, notably Martin Luther and John Calvin, in special regard. A second group are the Biblicists, who teach that the Word of God is found in the Bible alone. For these theologians the tradition must itself be checked as secondary to the Scriptures. The third group are the dialectical or crisis theologians, who emphasize the Word of God as God encountering man in Christ through the Scriptures, an experience attested by the Holy Spirit within the individual. The fourth group, to whom no name has become attached but who might be called the Churchmen, emphasize that it is the living Church of today which proclaims the Word of God to man. Theology, for this fourth group, becomes a criticism of, and a reflection upon, the utterances of the present-day Church as the voice of God in contemporary society. All four of these groups agree that God has revealed himself in Jesus Christ. They differ as to the form by which this revelation is declared to modern man, but they join with the Church Fathers in affirming that the heart of Christian theology is the revelation of God in Christ as confirmed by the Apostles in the Biblical record. *See also* BRAHMANISM; BUDDHISM; CHRISTIANITY; DOGMA; ISLAM; JUDAISM; RELIGION; THEISM. C. M. DeB.

**THEOPHRASTUS** [thi'ofra'stəs] (c. 370-287 B.C.), ancient Greek philosopher and scientist, was born in Eresus, Lesbos. He studied under Plato in Athens, then under Aristotle, whose close friend he became and whom he succeeded as head of the Peripatetic school in 323 B.C. His work paralleled Aristotle's in scope and scientific character. He wrote on metaphysics, logic, physics, zoology, botany, psychology, ethics, politics, civilization, religion, music, rhetoric, and education; and the specificity of his interests is indicated by titles that vary from Fire, Stones, Dizziness, and Intoxication, to Modes of Life, Piety, and Marriage. Most of his work is lost, but occasional large fragments provide a clear conception of its nature. His writings on plants, which remain, represent his most original scientific inquiry, the product of large-scale collection of materials, careful classification, and detailed study. Most popular of his surviving works is his *Characters,* a collection of thirty sketches of types such as the pretentious man, the arrogant, the distrustful, the surly, each delineated with masterful use of illuminating incident. The mean man, for example, when he goes abroad on public service, leaves at home the money given him by the state and



THEOPHRASTUS

CULVER SERVICE

borrows from his fellow-ambassadors; he keeps his sons home from school during February, which has many festivals, so that he can save the school fee.

Theophrastus worked essentially within the confines of the Aristotelian system, to expand the area of detailed knowledge. His spirit is critical, not slavish. In his analysis of nature and soul he is more naturalistic than his master; for example, he is more conscious of the difficulties in establishing a teleological view of nature. His ethics advocates the mean in conduct, happiness, friendship, and the intellectual life, and stresses the role of external factors as threats to peaceful contemplation. His life and character indicate that scientific activity was his supreme concern. A. E.

**THEORIES OF LANGUAGE ORIGIN.** The problem of the origin of language has occupied the minds of a great many eminent thinkers, from Plato and Aristotle to Ernest Renan and Otto Jespersen. The question was reexamined in full as late as 1946 in a book by G. Révész entitled *Ursprung und Vorgeschichte der Sprache,* but most twentieth-century linguists are inclined to regard the subject as wholly speculative and hypothetical or at least to dismiss it as lying outside the realm of linguistic science.

Until the end of the eighteenth century, three main theories on the origin of language divided the field of investigation: the traditional theological theory, based on the famous chapter of Genesis (xi) that describes the construction of the tower of Babel; the logical or conventionalistic theory, attributing the origin of language to an agreement among learned men to give a certain meaning to a certain word; and the theory of the "fantastic" origin of language, vaguely presented by Francis Bacon (1561-1626) and fully developed by G. B. Vico (1688-1744). G. B.

The theories discussed in more recent times can be roughly divided into two great classes, the biological and the anthropological. This division is fundamentally connected with a discussion once conducted among Greek philosophers, on the point of whether language existed by nature (*φύσει*) or by convention (*θέσει*). Adherents of the biological theories seek the origin of language in the tendencies and characteristics of the animal world; adherents of the anthropological theories, starting from the assumption that language is a purely human phenomenon, look in the history of language itself for its most archaic constitutive elements and concentrate especially on the speech of "primitive" tribes.

**Biological Theories.** The principal biological theories fall into two classes:

1. The theory of "expressive gestures and sounds" derives language from the "natural movements that express passions" (Descartes). Since interjections supply important evidence for this view, it is sometimes called the "interjectional" theory and sometimes, jocularly, the "pooh-pooh" theory.

2. The theory of "animal sounds" seeks analogies to the origin of the human language in the sounds emitted by animals, especially in those that can be observed in the study of apes.

**Anthropological Theories.** The principal anthropological theories are more numerous:

1. The "imitation" or "onomatopoeia" theory holds that all human language derives from the imitation of natural sounds (thunder, rain, cries of animals, etc.). This theory is sometimes called derisively the "bow-wow" theory.

2. The "babble" theory seeks the origin of language in the spontaneous babbling of children. Words like *daddy, mammy, pop, mom,* and many others are adduced in support of this view.

3. The "reflex" or "response" theory regards language as originally the emission of sounds in immediate, mechanical response to special external stimuli. It is frequently called the "ding-dong" theory.

4. The "song" theory, accepted by most of the ancient Greek philosophers and by many moderns, holds that singing was the original form of language.

5. The "disposition" or "function" theory assumes that man must have had some special disposition to speak before he began speaking and asserts, as one consequence of this assumption, that the capacity for logical thinking must have preceded language.

6. The "gesture-language" theory, which is one of the most popular, postulates that for countless ages before language came into existence man communicated through gestures alone. J. J. A. van Ginneken, the Dutch linguist, dates the beginning of oral language at 3500 B.C. at the earliest, maintaining that up to that time men expressed themselves by gestures or by the interjectional "clicks" which still exist in South African languages. In support of this theory it is argued that the higher apes learn gestures easily, that some primitive tribes express themselves better through gestures than through oral language, and that a gesture-language exists in actuality, namely, the language of mutes.

7. The "symbolical" theory, advanced by Suzanne K. Langer (*Philosophy in a New Key,* 1948), regards language as a form of symbolism. In this view, values are attached to objects, pictures, and sounds, and these values are symbolically expressed in language.

8. The "utilitarian" theory maintains that language originated from the practical necessities of human co-operation. This theory, which was defended by the Roman poet Horace, now has no important support among linguists or philosophers.

9. The "deception" theory is presented by E. H. Sturtevant in *An Introduction to Linguistic Science* (1947). Observing that voluntary communication can scarcely have been called upon except to deceive, Sturtevant concludes that "language must have been invented for the purpose of lying." This theory has been criticized as ruling out the factor of emotional stress in human utterances.

10. The "contact" theory, proposed by G. Révész, emphasizes the relation of the individual to a social unity. It regards language as the result of an innate trend in all social creatures toward reciprocal approach, contact, and understanding.

**Philosophical Theories.** The philosophical theories on the origin of languages may be divided into two main classes; the nativist and the empiricist, a division which corresponds roughly to that between the biological and the anthropological theories. The nativist theories maintain that the capacity of speaking is innate in man and therefore precedes experience; among the principal adherents of this view are W. von Humboldt, Max Müller, and Ernest Renan. The empiricist theories attribute the decisive influence, even in the first stages of language, to human experience, will, and thought; this is the view of Condillac, Hobbes, and Darwin, among others. The nativists incline to make of language an inevitable product of human tendencies, whereas the empiricists consider it a product of conscious choice. The nativists concentrate their attention on the way in which language originated; the empiricists stress the way in which it developed.

The issue between nativists and empiricists might be settled if there were enough evidence regarding persons who have grown to maturity without any contact with human

speakers. Four important cases have been recorded: Peter, "the Wild Boy," who was found in Hannover, Germany, in 1723; Victor, "the Savage of Aveyron," who lived alone in southern France at the end of the eighteenth century; and two girls, Amala and Kamala, who were found near Midnapur, India, in 1920. None of these spoke in isolation a language of any kind, and Victor never learned to speak at all, though he succeeded in mastering the alphabet of the deaf mutes.

**Theological Theories.** The theological theories of the origin of language maintain that language is a gift from God, or that it is the product of a wisdom inherent in nature through the will of God. Among the most famous followers of these theories may be mentioned Abelard, Duns Scotus, Jacob Grimm, and W. D. Whitney. For those who define language as a system of signs that express ideas, or as a logical structure, or as a way of thinking, a theological explanation of the origin of language is especially useful in order to bridge the gap that exists, in their conceptions, between the animal world and the world of humans. Those on the other hand who believe, with Croce and Vico, that language is expression, regard it as a product of natural tendencies.

**Methods of Study.** Several methods of study are open to the student of language origin. Some study the language of children, seeking in their utterances the most primitive forms of language, just as Darwinists try to reconstruct the history of the human and animal species in the successive transformations of the fetus. Some seek the early stages of speech in the "archaic" languages of primitive tribes; their studies have resulted in valuable discoveries, but it is probable that even the most primitive languages have a long history behind them. Others look to the careful study of languages in general for light on the origin of language; the study of Indo-European languages, for example, shows that the linguistic categories of the article and the adjective, and probably also the adverb and the conjunction, are of late creation, whereas nouns, verbs, and interjections are very old. Still others study the language of aphasiacs, applying the principle that sufferers from aphasia lose the elements of language in an order inverse to that in which they acquired them. Adherents of the biological theories of language origin enter still another field in their investigation, studying the gestures and utterances of the animal world. G. B.

**THEORY,** in music, basically the rudiments or elements of music, starting with the study of notation, key signatures, scales, musical terms, solfeggio, and sight-singing. The next step in order of difficulty is harmony, which consists of exercises in part-writing, correlated work at the keyboard, and harmonic analysis. Later comes the study of the polyphonic style in counterpoint, followed by a study of the canon and the fugue, an analysis of musical form and composition in homophonic forms for piano or small ensemble, and orchestration, including both analysis and scoring. A knowledge of all these elements is necessary to advanced composition for full orchestra. J. M. Ba.

**THEOS.** *See* Antiochus.

**THEOSOPHY** [thiɒ'sofi] (fr. Gr. *θεός*, God, and *σοφια*, wisdom), the name of a body of teachings, offering an explanation of the source and purpose of life. Its survey includes both anthropogenesis and cosmogenesis, linking into an orderly scheme of evolution, governed by absolute law, all of life, both material and spiritual. The concepts of theosophy may be traced in philosophical writings such as those of Plato, Plotinus, and the Christian Gnostics, and more directly in the scriptures of the world's great religions, particularly those of India, China, and Egypt. Theosophy is sometimes referred to as the Ancient Wisdom, or the Wisdom Religion.

The following concepts are basic to Theosophy: (1) there is postulated a First Cause which is eternal, unborn, and undying; it is the boundless and immutable principle, the infinite reality within which all manifestation has its being; (2) the primordial Source mirrors itself in the created universe, thus becoming the manifested God, or Logos; (3) from the causeless One Cause, the universe appears as cosmic Ideation from which proceeds the duality, spirit-matter, thence the trinity of spirit, matter, and the relationship between the two, or consciousness; (4) existing within the manifested consciousness, yet differentiated, are the myriad units of consciousness, each of which is a Divine Son, or Monad; (5) the cosmic purpose of the Monads is to evolve innate powers of conscious divinity by experiencing the limitations and mastering the environments of denser matter in the mineral, vegetable, and animal kingdoms of life; theosophy conceives that there is an evolution of consciousness paralleling the evolution of form, and that upon reaching the human stage, the Monad's destiny can be more swiftly accomplished as intelligent co-operation is awakened; (6) the Monad is man's immortal element of consciousness whose potentialities are being gradually released through cycles of reincarnation; (7) reincarnation is perceived as an orderly, periodic withdrawal and reappearance of man's Higher Self into mortal vestures; these vehicles of mind, emotion, and physical body afford further opportunity for experience and growth; (8) the cyclic recurrence of man's spirit in material form is determined by Karma, the law of action and reaction governing with perfect justice all events in the universe; and (9) the fruition of human experience is the illumined realization of the One Life, the recognition of which constitutes spiritual wisdom and provides the basis of ethics which guarantee that the awakened powers will be used to forward and not obstruct the evolutionary process; beyond that stage of fulfillment the destiny of man's spirit is infinite progress in the perfection of his divine nature.

The modern revival of theosophical thought began with the establishment of The Theosophical Society in New York City on Nov. 17, 1875, by Helena Petrovna Blavatsky, Colonel Henry Steel Olcott, William Q. Judge, and others. Colonel Olcott became the Society's first president and Mme. Blavatsky its first recording secretary. Though numerically small at first, the Society has grown into an international body organized in over fifty countries, with international headquarters at Adyar, Madras, India. The Society has developed an extensive literature, chief among which is Mme. Blavatsky's *The Secret Doctrine*. Succeeding Presidents Annie Besant (1907-1933), George S. Arundale (1933-1945) and C. Jinarajadasa (1946- ) have contributed further important works. The three objects of the Society are: (1) to form a nucleus of the universal brotherhood of humanity, without distinction of race, creed, sex, caste, or color; (2) to encourage the study of comparative religion, philosophy, and science; (3) to investigate the unexplained laws of nature and the powers latent in man. J. S. P.

**THEOTOKOPOULOS, KYRIAKOS.** *See* Greco, El.

**THE PAS.** *See* Pas, The.

**THERAPEUTAE** [therəpyu'ti], a religious sect which flourished in the first century of the Christian Era and is

described, among contemporary sources, only in Philo's *De vita contemplativa.* Strictly ascetic, the Therapeutae lived in separate cells where they spent the day in prayer, meditation, and study. They ate sparingly and only in the evening. Virgins were admitted to the group, but they sat apart in the dining quarters and did not mingle with the men. On the Sabbath the members met for a communal meal and discussion. A feature of their observances was a nocturnal celebration, at which they spent the whole night singing religious songs; it is not clear, however, whether this celebration was held every seven weeks or only on the principal Jewish festivals (Passover, Pentecost, and the Feast of Tabernacles). The Therapeutae had much in common with Christian monastic orders, and some scholars have suggested that they may have been Christians, but most maintain that they were a strictly Jewish sect, akin to the Essenes, from whom they may have separated. H. Bl.

**THÉRÈSE OF THE CHILD JESUS, ST.** [te′rɛ′z] (1873-1897), French virgin saint, was born Marie Françoise Thérèse Martin at Alençon in Normandy. At the age of fifteen she entered the Carmelite convent at Lisieux, where

ST. THÉRÈSE OF THE CHILD JESUS

BROWN BROTHERS

she later held for a few years the office of mistress of novices. Her autobiography (*L'Histoire d'une âme*) combines a delightful freshness of outlook with great depth of spiritual insight. Though professing herself "a very little soul, who can only offer very little things to our Lord," Thérèse Martin was generally acclaimed a saint shortly after her early death. She was beatified in 1923 and canonized in 1925. Her deathbed promise, "I will spend my Heaven in doing good upon earth," has been seen fulfilled in numberless miracles attributed to her intercession. Patroness of foreign missions, she is commemorated October 3; in her honor have been dedicated many churches and shrines throughout the world, often under the title of the "Little Flower." W. C.

**THERMOCHEMISTRY,** a study concerned with heat accompanying chemical change.

**Kinetic Nature of Heat.** At absolute zero, there is practically no motion of molecules, or of atoms within them. As the temperature is raised, the atoms begin to vibrate. At still higher temperatures, rotation and eventually translation of the molecule through space takes place. Energy is also stored up within the particle as electronic energy by having its electrons in certain excited energy levels. The sum of these energies makes up the temperature of the particle. In other words, heat is a form of motion, and the Kinetic-Molecular theory postulates that the kinetic energy of a particle varies directly as the temperature, i.e., $\frac{1}{2}mv^2 \propto T$, for a particle of mass $m$, moving with velocity $v$, at absolute temperature $T$. From this is deduced the gas law expression for $n$ molecules that: $PV = kT = \frac{1}{3}\ nmv^2$.

**Endothermic and Exothermic Reactions.** Chemical reactions either liberate heat (exothermic) or consume it (endothermic). Reactions of the former type are far more abundant. The first example below shows that when 2 moles of gaseous hydrogen (2 x 2.016 grams) combine with 1 mole of gaseous oxygen (32 grams) to give 2 moles of liquid water (2 x 18.016 grams) sufficient energy is liberated to raise 136,828 grams of water one degree.

*Exothermic Reactions:*

$$2H_2(g) + O_2(g) \longrightarrow 2H_2O(l) + 136{,}828 \text{ cals.}$$

$$C(s) + O_2(g) \longrightarrow CO_2(g) + 94{,}400 \text{ cals.}$$

$$HCl(aq) + NaOH(aq) \longrightarrow NaCl(aq) + H_2O(aq) + 13{,}880 \text{ cals.}$$

$$Fe_2O_3 + 2Al \longrightarrow 2Fe + Al_2O_3 + 198{,}800 \text{ cals.}$$

*Endothermic Reactions:*

$$H_2 + I_2 \longrightarrow 2HI - 12{,}000 \text{ cals.}$$

$$N_2 + O_2 \longrightarrow 2NO - 43{,}000 \text{ cals.}$$

At one time, Thomsen and Berthelot (1854) wrongly postulated that exothermicity was an index of how fast a reaction would occur. Such a theory left no possibility of endothermic reactions; it was eventually disproved.

**Heats of Combustion.** The heats of reaction between a great many organic compounds and oxygen have been carefully measured; these have thrown much light on the forces binding atoms together. Heats of combustion per mole at 18°C. are 783,400 cals. for benzene, 1,349,600 cals. for cane sugar, and 170,900 cals. for methyl alcohol.

**Hess's Law of Constant Heat of Reaction.** Hess enunciated, in 1840, that the heat evolved in changing from state $A$ to state $B$ is the same irrespective of the mode of change. This law enables one to utilize heats of formation of substances in calculating their heats of reaction. For instance, heat of combustion for $2Al$ is 389,500 cals., and for $2Fe$ is 190,700 cals. From this it is seen that the reaction $Fe_2O_3 + 2Al \longrightarrow 2Fe + Al_2O_3$, which involves, first, the breaking of the iron-oxygen bonds (-190,700 cals.); then the formation of aluminum-oxygen bonds (+ 389,500 cals.) should give a heat of reaction of (389,500 — 190,700) = 198,800 cals. *See also* HEAT AND THERMODYNAMICS. H. N. A.

**THERMOCOUPLE.** *See* ASTRONOMICAL INSTRUMENTS (*Astrophotography*); HEAT AND THERMODYNAMICS (*Measurement of Temperature*).

**THERMODYNAMICS.** *See* HEAT AND THERMODYNAMICS.

**THERMOMETER.** *See* HEAT AND THERMODYNAMICS; MEASUREMENTS, STANDARDS AND UNITS OF; METEOROLOGY (*Weather and Weather Observations*).

**THERMOMETRIC TITRATION.** *See* ANALYTICAL CHEMISTRY (*Physicochemical Methods*).

**THERMOPYLAE** [thərmɒ′pili], a famous pass between Thessaly and Locris in ancient Greece which was the main

gateway from the north to central Greece. In antiquity the pass was long and narrow, with the sea on the east and high cliffs along the opposite side. It was here in 480 B.C. that the Spartans under Leonidas and their Greek allies made their historic ten-day stand against a numerically superior Persian force, only to be overwhelmed when a traitor guided a portion of the Persian army around Thermopylae by a little-known mountain road. A similar battle for the pass occurred in 279 B.C., when the Gauls under Brennus defeated the defending Greeks just as the Persians had done in 480. In the next century, Antiochus III, the Seleucid king, attempted to hold the pass against the Romans (191 B.C.), but on this occasion the Romans were successful in forcing the pass by a frontal attack. In modern times the pass has been considerably widened, and its appearance is quite different from what it was in the days of Leonidas. T. B. J.

**THERMOSTATS,** self-operating devices for controlling temperatures, applied first to gas water heaters in 1897 and then to gas ovens in 1915. Soon, thereafter, similar devices were used for the control of house heating and were applied to safety pilot burners (thermostatic safety pilots).

The principle of operation involves the differential expansion of two metals, as the bimetallic strips and "rod in tube", or of liquid in a metal bulb and tube. In the former, the movement is applied directly to the valve mechanism regulating the fuel; in the latter, the force of the expanding liquid is transmitted through a metallic bellows to the mechanism. F. Wi.

**THERSITES** [thərsai′tiz], in Greek legend, an ugly and insolent warrior in the Greek forces at Troy and the son of Agrius. He bitterly attacked Agamemnon in the assembly following Achilles' withdrawal from fighting and was chastised for this behavior by Odysseus. Later he mocked Achilles for mourning over Penthesilea's death, and Achilles slew him in anger. *See also* TROILUS AND CRESSIDA. G. E. D.

**THESEUS** [thi′sus], in Greek legend, the great hero of the Athenians, the son of Aegeus, king of Athens, and Aethra, daughter of King Pittheus of Troezen. Theseus was born when Aegeus, being childless, visited Pittheus, who arranged for him to have intercourse with his daughter. Another version relates that Theseus was the son of Aethra and the god Poseidon, and modern writers suggest that Aegeus was a local form of Poseidon himself. Theseus grew to maturity at Troezen and set out for Athens, taking the sword and sandals left behind by Aegeus. On the way he destroyed many robbers and monsters, his deeds recalling the more illustrious ones of Heracles. Theseus' adventures included the killing of four notable malefactors: the brigand Periphetes; Sinis, who tied people to two pine-trees bent together and tore his victims apart by releasing the trees; Sciron, who kicked people into the sea; and Procrustes, who fitted his victims to a bed by stretching or cutting off their limbs.

When Theseus arrived at Athens, Medea, his father's wife, attempted to poison him, but Aegeus, recognizing the sword as his own, acknowledged the youth as his son and successor. Theseus' next exploit was to capture the fire-breathing bull of Marathon, which Heracles had brought from Crete. Then he went to Crete as one of the groups of youths and maidens offered each year to the Minotaur. On the way, Minos, who was conducting them, threw overboard a gold ring and challenged Theseus, if he were really the son of Poseidon, to jump overboard and bring it back; Theseus not only returned with the ring, but also brought back a golden crown which he had received from Amphitrite. At Crete Theseus slew the Minotaur with the assistance of Ariadne, the daughter of Minos, and fled with her by sea, deserting her later on the island of Naxos. He had promised Aegeus to hoist a white sail if he returned safely; but he forgot his promise as he approached Attica, and Aegeus, perceiving the black sail and believing that Theseus had perished, hurled himself from a rock to his death. Theseus thus became king of Athens.

The hero took part in numerous legendary exploits, the voyage of the Argonauts, for example, and the Calydonian hunt. He also made an expedition against the Amazons, carrying off their princess, Antiope, and defeating the Amazon invasion of Attica which followed this exploit. By Antiope Theseus had a son, Hippolytus, and after Antiope's death he married Phaedra, another daughter of Minos. He formed a firm friendship with Pirithous, king of the Lapithae, and aided him in a fight against the Centaurs. With Pirithous he visited Sparta and carried off Helen, who was later rescued by her brothers Castor and Pollux, and he joined Pirithous in a trip to the underworld when the latter desired to abduct Persephone. Both heroes were imprisoned in the lower world, but Theseus was later rescued by Heracles.

During Theseus' absence from Athens, Phaedra fell in love with Hippolytus, who had devoted himself to Artemis and a life of chastity. When her love was repulsed, she committed suicide and left behind a false accusation of Hippolytus. On his return Theseus accordingly cursed his son, and, since Poseidon had granted him the fulfillment of three wishes, the curse was effective: Hippolytus was dragged to death by his horses, which were frightened by a monster sent by Poseidon from the sea. Theseus, unable to re-establish his authority after his return, went to Scyros, where he was slain by King Lycomedes. The Athenians believed that their dead hero reappeared and aided them at the Battle of Marathon. *See also* AMAZONS; ARIADNE; MINOTAUR; PIRITHOUS. G. E. D.

**THESPIS** [thɛ′spɪs], Greek dramatist, reputed father of Attic tragedy, was born in Icaria, a village in Attica, and flourished in the sixth century B.C. No part of his works is extant. He is supposed to have created tragic drama by introducing an actor with a speaking part, impersonating a legendary or historical character, into a performance which had previously been rendered by a chorus alone. According to one ancient authority, Thespis took the actor's part himself. He is also credited with having initiated the use of linen masks on the stage. It may be, as Horace suggested, that he took his plays about on wagons to local festivals. It is possible that he gave his first performance at Icaria, and probable that he gave performances at Athens before dramatic competitions were organized there. His first performance at Athens may have been as early as 560 B.C. He is supposed to have won his first victory in the competitions at Athens in 534 B.C., probably at the Great Dionysia festival. S. D. At.

**THESSALONÍKI** or **SALONIKA** [thɛ′sɑlɔnyi′ki, sæ′-lɔni′kə], the capital and chief port of the department of the same name in Greek Macedonia on the Gulf of Thessaloníki, east of the Axiós River delta. The center of convergence for some of the most important routes crossing the Balkan Peninsula, it has suffered from many invasions. St. Paul visited the city and addressed to converts there his Epistles to

the Thessalonians. Thessaloníki was taken by the Saracens in 904 and by the Normans in 1185. During the Middle Ages it was part of the Byzantine Empire and in the thirteenth century was capital of the kingdom of Thessalonica created by Baldwin I, Emperor of Constantinople, for Boniface III, Count of Montferrat, who ruled Greece and Macedonia. It was under Turkish rule from 1430 to 1912, when it became part of Greece. An Allied base in World War I, the city was destroyed by fire in 1917 and was rebuilt by refugees. Reclamation of neighboring marshland was begun in 1935. During World War II, the city was occupied by the Germans from April 1941 to October 1944. The port has free-trade facilities and the city is an important industrial center. The manufacture of carpets, textiles (cotton, silk, and wool), flour, jute sacks, machinery, leather goods, and tobacco are the major industrial enterprises. Pop. 1951, 217,049.

The department of Thessaloníki, with an area of 2,436 sq. mi., is bounded by Yugoslavia and Bulgaria on the north, the Aegean Sea on the south, and by the departments of Sérrai on the east, Lárisa on the south, and Flórina and Kozáni on the west. The Khalkidhikí Peninsula lies southeast of the city of Thessaloníki. Pop. 1951, 458,271. S. Van V.

**THESSALONÍKI (SALONIKA), GULF OF,** or **GULF OF THERMAIKOS,** in the northwestern part of the Aegean Sea, between Thessaly and the Khalkidhikí Peninsula. The gulf is about 30 mi. wide in the south, but narrows to 10 mi. near the harbor of Thessaloníki. The northern shore is the low, malaria-infected delta of the Axiós (Vardar) and Alíakmon (Vistritsa) rivers. Thessaloníki, the chief seaport of Greek Macedonia, is situated at the head of the gulf.

**THESSALY** [thɛ'səli], a division of ancient Greece, located on the east coast and bounded on the north by Macedonia, on the west by Epirus, on the south by Doris and Locris, and on the east by the Aegean Sea. Although Thessaly contained much rugged and mountainous country, there were also large fertile plains. The country was not politically unified during the Classical period until it came under the influence of the Macedonians in the fourth century B.C.; two centuries later, it became a Roman province. The Thessalians were slow to become civilized; although the agricultural output of Thessaly must have been considerable, the region was chiefly known for horses. Modern Thessaly roughly corresponds to the ancient division and includes the departments of Lárisa, Kardhítsa, Magnisía, and Tríkkala. It was ceded to the Greek kingdom in 1881. T. B. J.

**THETFORD MINES** [thɛt'fərd], a city in Megantic Co., Quebec, Canada, situated on Highway 1, about 70 mi. south of the city of Quebec. About 85 per cent of the world's supply of asbestos is mined in the environs, as are considerable quantities of talc and chromic iron. Thetford Mines has several industrial establishments, including foundries and asbestos, sash and door, and cement-block factories. The city was incorporated in 1912, and is served by the Quebec Central Railway. Pop. 1951, 15,095. D. F. P.

**THETIS** [thi'tɪs], in Greek mythology, a sea goddess, the daughter of Nereus and Doris. Like the other Nereids she dwelt in the sea. Both Zeus and Poseidon wooed her until they learned that her son was fated to be mightier than his father. Thetis was then wedded to Peleus, after he had managed to hold her through a series of rapid transformations. It was at their wedding celebration that Eris threw the golden apple among the assembled gods. The famous son of Thetis was Achilles. *See also* ACHILLES; PELEUS; TROJAN WAR. G. E. D.

**THIARD (or TYARD) PONTUS DE** [tya'r] (1521-1603), French poet, was born in Bissy, Saône-et-Loire, France, in 1521. His first book of poems, *Les Erreurs amoureuses* (1549), appeared just before Du Bellay's *Deffense et illustration de la langue françoyse,* which served as the rallying point about which the Pléiade was formed, and Thiard was immediately adopted as a member of that group. While most of the other members belonged to the Loire region and Paris, Thiard's literary activity centered around Lyon, where interest in philosophy was strong. The Platonists were especially influential, and Thiard was drawn into this school of philosophical writing. In 1551 he translated a curious book, of Platonic inspiration, by a Portuguese Jew writing in Italian; this book, under the title of *Leon Hébrieu de l'amour,* Thiard dedicated to the king. Following this, he wrote six *Discours philosophiques* between 1552 and 1556, describing his theory of poetical frenzy and the then popular concept of an alliance between poetry and music. His later work includes *Nouvelles oeuvres poetiques* (1573) and *Douze fables des fleuves et fontaines* (1585).

In his middle years Thiard had already begun to move away from poetical writing, and in this evolution from a nearly pagan Renaissance attitude to a Christian spirituality he anticipated one of the trends of the coming Classical period. In 1552 he had become canon of St. Vincent Cathedral in Mâcon, and in 1578 he became bishop of Chalon-sur-Saône, where he died in 1603, the last survivor of the Pléiade. His poetry, much admired in his day, now seems obscure and artificial. H. F. M.

**THIBAULT, JACQUES ANATOLE.** *See* FRANCE, ANATOLE.

**THIBODAUX** [tɪ'bodo'], a town in southeastern Louisiana, the parish seat of Lafourche Parish, situated on Bayou Lafourche, in a flat section surrounded by lakes and bayous, 45 mi. southwest of New Orleans. Natural local resources include oil, gas, and timber. Thibodaux was founded in 1801 by Henry Schuyler Thibodaux, after whom it was named, and it was incorporated as a town in 1830. The local government is the commission type. Thibodaux is on the site of the old Spanish Trail. Of historic interest are the Rienzi Plantation, established in 1796 by Queen Maria Louisa of Spain, and the Acadia Plantation, used during the Civil War as a camp for Federal forces. The town is the birthplace of Edward Douglass White, Chief Justice of the United States Supreme Court from 1910 to 1921. Transportation is supplied by the Southern Pacific and the Texas and Pacific railroads. Sugar cane, the chief crop of the surrounding farm area, has determined the town's principal industries: sugar refining and the manufacture of farm machines, particularly those used for cane harvesting. Pop. 1950, 7,730.

**THIEF RIVER FALLS,** a city in northwestern Minnesota, the county seat of Pennington Co., situated at the confluence of the Thief and Red Lake rivers, about 75 mi. northwest of Bemidji. It is a distributing center, handling groceries, fruit, poultry, and dairy products for the surrounding farm area, and its manufactures include butter, cheese, and soft drinks. It was incorporated in 1896. The city is governed by a mayor and city council. Thief River Falls was once called Rockstad. In City Park at the junction of the Red Lake

and Thief rivers, are the ruins of an old Indian settlement. The city is served by the Great Northern and the Minneapolis, St. Paul & Sault Ste. Marie railroads. Pop. 1950, 6,926.

**THIEL COLLEGE** [ti'l], an accredited, coeducational, privately controlled college of arts and sciences affiliated with the United Lutheran Church in America. It was founded in 1866 and the charter was granted in 1870. The 34-acre campus is located in Greenville, Pa. The degrees offered include the A.B. in liberal arts and the B.S. in business administration. Some dormitories have been provided for men and women. Additional living accommodations for men are provided by fraternities. Scholarships are available, and there is a small loan fund. Opportunities for self-help enable some of the students to earn part of their expenses. *For statistics see* COLLEGES AND UNIVERSITIES. J. R. To.

**THIERS, LOUIS ADOLPHE** [tyɛ'r] (1797-1877), French statesman and writer, was born in Marseille, Apr. 16, 1797. He studied law at Aix and was admitted to the bar in 1821. In 1822 he began to direct the Paris newspaper, *Constitutionnel,* and in 1829 helped to found the *National,* a paper that helped to foment the Revolution of 1830. Thiers was elected to the House of Deputies in 1830 and two years later became minister of the interior. He was elected to the French Academy in 1833 and in 1836 became premier, but clashed with the king, Louis Philippe, and as a consequence resigned. He resumed his campaign of parliamentary opposition and became president of the council and minister of foreign affairs four years later, but was again forced out of office. He spent the next two decades in virtual retirement, including a brief period of imprisonment and exile after the *coup d'état* of 1852 by which Louis Napoleon became Emperor Napoleon III. Thiers returned to politics in 1863, was elected to the House of Deputies, and for the next seven years led the small party of anti-Imperialists.

The rise of Germany prompted Thiers to counsel moderation until France could acquire sufficient strength to risk a conflict. When Napoleon's defeat at Metz and his surrender at Sedan were followed by the establishment of the Third French Republic, Sept. 4, 1870, Thiers was chosen to be the first president of the new republic. The Paris Commune later opposed him and seized the capital, and only after considerable fighting were the forces of the National Assembly, directed by Thiers, able to reassert governmental authority. Thiers then agreed to the humiliating German peace treaty. Despite his efforts to restore order and prosperity, he met considerable opposition and in May 1873 was forced to resign and retire to private life.

Thiers' literary fame rests on two works. The pro-Napoleonic *Histoire de la révolution française* (10 vols., 1823-1827) was published before he was thirty. His *Histoire du Consulat et de l'Empire* (20 vols., 1845-1861) was written in the years of his retirement from public life. Thiers died in Paris, Sept. 3, 1877. T. R. H.

**THIRD ESTATE.** *See* ESTATES GENERAL.

**THIRD INTERNATIONAL (COMINTERN)** [kɒ'mɪntɜ'rn], an organization of Communist parties founded in Moscow in March 1919 and formally disbanded in May 1943. Its predecessors were a short-lived International Workingman's Association, established in 1864, and the Second, or Socialist, International, formed in 1889. The latter, a federation of the socialist and labor parties of many countries, wielded considerable influence in European politics until it was disrupted by internal conflicts over the question of participation in World War I. The Communist International, or Comintern, was created by the Bolsheviks, led by Lenin, when they found they could not dominate efforts to revive the Second International. The Comintern displayed the central authoritarianism that characterizes the Russian Communist Party. To a large extent it was supported financially by the Soviet government, and its leadership was almost wholly the same as that of the Soviet Union. The Comintern was conspicuously less representative of the proletariat than of the revolutionary-minded intelligentsia. Only briefly was the Comintern devoted overtly and primarily to the cause of promoting proletarian revolutions in other countries. Its major effort, which took place in China in the 1920's, failed. During most of its existence it was almost exclusively an instrument of Russian foreign policy. Communists in other countries were instructed to join trade unions and other organizations so as to influence their actions, as desired by the Soviet Union. That the control of Russian Communists over the Communist parties of other countries relaxed after World War II was confirmed in October 1947 by the formation of the Communist Information Bureau, or "Little Comintern," to co-ordinate the activities of European Communist parties. V. B. Z.

**THIRTY-NINE ARTICLES OF THE ANGLICAN CHURCH, THE,** a confession of faith, related to various other confessions of faith, among them the Helvetic, the French (Gallic), the Belgic, and the Scottish. All of these, prepared in the sixteenth and seventeenth centuries, set forth, as against Rome, what the churches of the Reformation believe and teach. The Thirty-Nine Articles, called in the Prayer Book the "Articles of Religion," were drawn up in 1563, the fifth year of Elizabeth's reign; they were a careful revision of the articles, forty-two in number, which had been prepared largely by Archbishop Cranmer in 1552, during the reign of Edward VI, which were in turn a revision of articles of the same number prepared by Cranmer two years earlier. Charles Hardwick, in his *History of the Articles of Religion,* shows conclusively that Cranmer was greatly influenced by the Augsburg Confession; the Thirty-Nine Articles reflect the same dependence, though in matters upon which the two enumerations differ, the Thirty-Nine Articles are apparently more influenced by the Confession of Württemberg. Finally, the Thirty-Nine Articles, though they largely reflect Lutheran doctrine, on the question of the Lord's Supper favor rather the position of the Reformed Church.

The first five articles are concerned with the Holy Trinity. Articles Six and Seven define the inspiration of the Scriptures, and list the books of the Old and New Testaments and the Apocrypha. Article Eight affirms the acceptance of the Nicene, the Athanasian, and the Apostles' creeds. Articles Nine through Eighteen deal with various aspects of the working of God's saving grace, with original sin, free will, justification, good works, works of supererogation, the sinlessness of Christ, sin after baptism, predestination and election, and salvation only by the name of Christ. Articles Nineteen through Thirty-Six are concerned with the Church and its authority, the sacraments, the ministry, general councils, purgatory, the marriage of priests, excommunication, traditions in the Church, homilies, and the consecration of bishops and ministers. The last three articles concern the relation of Church and State, maintaining that the Queen's Majesty "hath the chief power" in matters civil and ecclesiastical; that the holding of private property is Christian; and that the tak-

ing of oaths ("when the magistrate doth require") is lawful for a Christian.

While the articles definitely repudiate Romanism, approving, for example, the marriage of priests, denying transubstantiation, rejecting the authority of tradition, and strongly asserting that "the Bishop of Rome hath no jurisdiction in this Realm of England," they equally firmly assert that the Church of England is a product of historical Christianity, and that, in fact, it adheres to the primitive faith of the Church and is in no way revolutionary. While the manner of wording of those articles on predestination and election allows of a Calvinistic interpretation, an Arminian would have no difficulty in reconciling himself to their teaching. The articles are strongly on the side of law and order, repudiating vigorously the communistic leanings of Anabaptism. Nothing is said in the articles about the doctrine of apostolic succession; Article Thirty-Six asserts that the ordination of all those in clerical orders who were consecrated according to the rites laid down in Cranmer's Prayer Book in the third year of Edward VI is both valid and regular.

The outstanding characteristic of these articles is their moderation. The Church of England is Protestant, but definitely catholic too, not in the Roman sense, but catholic in that it makes up a continuous part of the long history of the church universal. It therefore can make its appeal to the moderates of both groups, Roman Catholic and Protestant alike. M. J. H.

**THIRTY YEARS' WAR,** the term applied to the conflict originating within the territory of the Holy Roman Empire in 1618 and ultimately involving almost all of the Continental powers. The war perpetuated the disunity and chaos characteristic of Central European politics since the sixteenth century and made permanent the split between Protestant and Catholic Europe originating in the Reformation. France emerged as the leading Continental power, while Spain relinquished the military supremacy she had enjoyed for over a century.

The character of the war, with its strange admixture of political and religious motives, is clearly foreshadowed in its origins. Bohemia, which had been ruled by the Hapsburgs since the sixteenth century, was in the midst of a national and religious revival under the leadership of the strongly Protestant and fiercely patriotic local nobility. The latter refused to elect Ferdinand of Austria to the Bohemian throne and offered it instead to the Protestant Count Palatine Frederick. The latter accepted the offer and thus precipitated a war involving the member states of the Holy Roman Empire. Catholic Germany, in conjunction with the armies of Hapsburg Spain, succeeded in defeating the Bohemians at White Mountain in 1620. As a result the Bohemian crown was conferred on the Emperor, and it seemed as if the war were about to end. At this point, however, began the first of the foreign interventions which were to keep the conflict raging for another twenty-five years. First Christian IV of Denmark invaded Germany in 1625 as the protector of Protestant interests, but the Imperial armies under Tilly and Wallenstein inflicted a series of reverses on the Danish army, and by 1627 it seemed that the Holy Roman Emperor was about to re-establish a new and unified German state. His unfortunate policy of restitution and restoration of Church lands, however, led to alarm among the hitherto neutral Protestant princes and drew Gustavus Adolphus of Sweden into the conflict as the champion of the Protestant party. From 1631 to 1632 the Swedish army marched victoriously over Germany, defeating the best troops of the Emperor and giving new strength to the Protestant cause, but with the death of Gustavus Adolphus at the Battle of Lützen in 1632 the Protestant fortunes suffered a heavy and seemingly irreparable loss.

At this point France, then under the guidance of Richelieu, entered the war on the Protestant side. Richelieu was not motivated, needless to say, by any affection for Protestantism. He saw rather an opportunity to defeat the Spanish and Austrian Hapsburgs, the traditional enemies of France, and he did not hesitate to avail himself of this opportunity. For the next fifteen years French, Spanish, Swedish, and German troops fought in Germany, Italy, Flanders, and the Pyrenees, and the two most capable French commanders, Turenne and Condé, proved to be more than a match for the Imperial troops and even the famous Spanish infantry. Peace negotiations were begun as early as 1641, but it was not until the brilliant French campaign of 1648 that the Emperor was finally convinced that further warfare was useless, and hostilities were ended by the Treaty of Westphalia. The war with Spain, however, dragged on for another eleven years and was concluded only by the Treaty of the Pyrenees in 1659. M. K.

**THISBE.** *See* PYRAMUS.

**THISTLE** [thɪ′səl], an herbaceous plant of the family Compositae having spiny or prickly foliage. This large genus, *Cirsium,* is made up of the true thistles, which are stout, erect herbs bearing large, showy, flower heads of purple, white, or yellowish tubular flowers. They vary in size between 1 ft. and about 8 ft. The spiny leaves are deeply lobed or cut. Out of the 200 species native to the North Temperate

SWAMP THISTLE, CIRSIUM MUTICUM

Zone, some 70 are found in North America. In the Pacific states, representative species are the Sierra thistle, *C. californicum;* the western thistle, *C. occidentale;* the desert thistle, *C. mohavense;* and the Indian thistle, *C. edule.* On the eastern half of the continent are found the swamp thistle, *C. muticum;* the pasture thistle, *C. odoratum;* the field thistle, *C. discolor;* and the roadside thistle, *C. altissimum.* The Canada thistle, *C. arvense,* which was introduced from Europe, has become a pestiferous weed. In addition to the true thistles, there are many other prickly leaved plants

which are commonly known as thistles. Among them are the blessed thistle, *Cnicus benedictus;* the Scottish thistle, *Onopordon acanthium;* the milk thistle, *Silybum marianum;* the star thistles, *Centaurea;* and the globe thistles, *Echinops.*
J. C. Wis.

**THOMAS, ST.** (Syriac, "twin"), called also Didymus (Greek, "twin"), one of the twelve Apostles. The Gospel of John portrays his enthusiastic devotion to his Master: "Let us go also and die with him" (xi: 16); his slowness to grasp the true personality of Christ: "Lord, we know not whither thou goest" (xiv: 5); and his initial incredulity of the Resurrection: "Except I shall see in His hands the print of the nails and put my hand into His side, I will not believe" (xx: 25). When the risen Christ appeared in the Cenacle again, Thomas confessed His divinity: "My Lord and my God" (xx:28). Tradition maintains that St. Thomas journeyed to India and founded seven churches at Malabar. After his martyrdom near Madras, his body was supposedly buried at Mylapore. Members of the ancient Christian churches of southern India are called "Christians of Saint Thomas." His feast is December 21. W. C.

**THOMAS, EARL OF LANCASTER.** *See* LANCASTER.

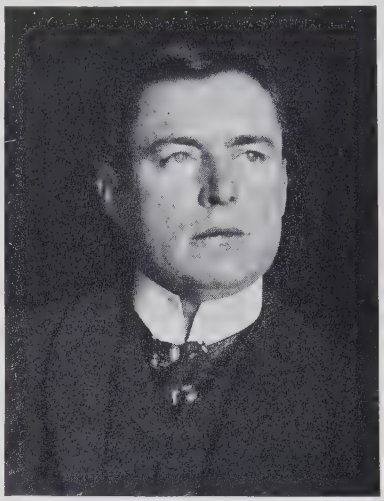
**THOMAS, ANDRÉ ANTOINE** [tɔ′mɑ′] (1857-1936), French philologist and linguist, was born at Saint-Yrieix-La-Montagne (Creuse) on Nov. 29, 1857. He studied at the École des Chartes from 1875 to 1878, and then for three years at the École Française in Rome; from 1881 to 1889 he taught Provençal language and literature at Toulouse, and from 1889 onward he was in Paris as a professor of Romance philology and French medieval literature. In 1904 he became a member of the Académie des Inscriptions et Belles Lettres, a position that he held until his death in 1936.

Thomas was an extremely prolific and sound scholar. Among his most important works in the field of literature, history, and textual criticism may be mentioned *Les États provinciaux de la France centrale sous Charles VII* (1879-1880); *Nouvelles recherches sur l'entrée d' Espagne* (1882); *Francesco da Barberino et la littérature française en Italie au moyen âge* (1883); *Documents historiques bas-latins, provençaux et français* (with Leroux and Molinier, 1883-1885); and *Poésies complètes de Bertrand de Born* (1888).

In the field of linguistics Thomas represents the most rigid Neogrammatical tradition, stressing close adherence to "phonetic laws" and giving phonetics priority over meaning. His chief contributions to linguistics are collected in his *Essais de philologie française* (1897), *Mélanges d'étymologie française* (1902), and *Nouveaux essais d'étymologie française* (1904). With Arsène Darmesteter and Adolphe Hatzfeld, Thomas published the excellent *Dictionnaire général de la langue française* (1889-1900), which continues to be a standard work. G. B.

**THOMAS, AUGUSTUS** (1857-1934), American playwright, was born Jan. 8, 1857, in St. Louis, Mo. Leaving the St. Louis public schools at the age of fourteen, he worked for several years in a railroad office and later as a newspaperman in his native town and in Kansas City. The theatrical activities, both amateur and professional, in which he engaged at this time encouraged him to become a playwright, but *Alone* (1875), his first full-length effort, was not a success. In 1888, as Julia Marlowe's manager, he went to New York, and that city became his permanent home. Thomas' first notably successful play, *Alabama* (1891), gave him a pattern for several other plays of local color, including *In Mizzoura* (1893) and *Arizona* (1899). Some light comedies, among them *Mrs. Leffingwell's Boots* (1905), were followed by his most substantial dramas, *The Witching Hour* (1907), dealing with thought-reading and hypnotism; *As a Man Thinks* (1911), which discussed the double standard of morals; and *The Copperhead* (1918), the story of a Northern spy.

Before his death on Aug. 12, 1934, Thomas had written over sixty plays, long and short. A traditionalist rather than



AUGUSTUS THOMAS

CULVER SERVICE

an experimenter, Thomas was concerned in his plays with theatrical, even melodramatic, situations more than with ideas, but he had a gift for stage effectiveness, and for years he was one of America's most highly regarded dramatists.
O. S. C.

**THOMAS, CHARLES LOUIS AMBROISE** [tɔ′mɑ′] (1811-1896), French composer, was born Aug. 5, 1811, in Metz. After winning the Grand Prix de Rome in 1832, he produced several successful works at the Opéra Comique, but when he tried his hand at serious opera he found that competition with more experienced composers of his time was too great and returned to the Opéra Comique. Here he composed *Psyché* (1857), *Le Carnaval de Venise* (1857), *Mignon* (1866), and *Hamlet* (1868), but in 1871 he was appointed director of the Paris Conservatory, and this virtually ended his career as a composer. Thomas died in Paris, Feb. 12, 1896, and of his works only the tuneful and charming *Mignon* now holds a firm place in the standard repertoire.
D. L. E.

**THOMAS, CHRISTIAN FRIEDRICH THEODORE** (1835-1905), German-American orchestral conductor, was born in Esens, Hannover, Germany, Oct. 11, 1835. Thomas, who came to the United States at the age of ten, was an important musical pioneer in this country during the last half of the nineteenth century, and his pioneering tours in the East and Middle West after 1869 brought good music to many who never before had heard a symphony orchestra. In 1891 he founded the Theodore Thomas Orchestra of Chicago, which, after his death in that city, Jan. 4, 1905, became known as the Chicago Symphony Orchestra. E. L. F.

**THOMAS, DYLAN** (1914-1953), British poet, was born in October 1914 in Carmarthenshire, Wales. He attended Swansea Grammar School and began his career as a writer at an early age. The prominent poets of the 1930's, W. H. Auden and Stephen Spender, had been preoccupied with society; Thomas, ignoring Marx, became preoccupied

with the nature of man, especially the unconscious mind. The poems of *18 Poems* (1934) are Freudian dreams. Their manifest level is a surrealistic confusion of contradictory images, but the latent level, when subjected to Freudian analysis, is simple. Thomas' theme is the cycle of birth and death, and his poetry depends upon the interaction between the rich surface and the latent theme. His first volume was followed by similar collections: *Twenty-Five Poems* (1936), *The Map of Love* (1939), and *Deaths and Entrances* (1946). Some of the less introspective poems of *Deaths and Entrances* concern religion, air raids, and the poet's youth. Thomas also published some surrealistic short stories in *The Map of Love*. His *Portrait of the Artist as a Young Dog* (1940) consists of autobiographical sketches. After World War II, Thomas became a commentator on poetry for the British Broadcasting Company. In America the following of his works have appeared: *The World I Breathe* (1939), *New Poems* (1942), *Selected Writings* (1946), *In Country Sleep* (1952), *Collected Poems* (1953), and *Under Milk Wood* (1954). He died in New York City on Nov. 9, 1953.

W. Y. T.

**THOMAS, GEORGE HENRY** (1816-1870), Union soldier, was born on July 31, 1816, in Southampton Co., Va. He graduated from West Point in 1840 and fought in the Mexican War. Although of Southern birth, Thomas remained in the Federal Army when the Civil War broke out. He assumed command of a Union division late in 1861 and defeated a Confederate force at Mill Springs in southern Kentucky on Jan. 19, 1862, the first decisive Federal victory in the west. He served, successively, under Halleck, Buell, and Rosecrans in the campaigns of 1862 and 1863 which led, eventually, to the vital battles of Chickamauga and Chattanooga. At Chickamauga, in September 1863, Thomas' defense of the center of the broken Union line in the face of the furious Confederate attack earned him the sobriquet "Rock of Chickamauga," and helped the Union forces to effect an orderly withdrawal to Chattanooga. There, in November, with General U. S. Grant in command of all Union forces, Thomas directed the successful assault on Missionary Ridge which routed the Confederates and forced them to retreat into Georgia. In 1864, after Sherman had captured Atlanta and had begun his march to the sea, Thomas successfully protected the Union communication lines by intercepting and defeating Confederate troops under Hood at Nashville, December 15 to 16, in one of the most one-sided battles of the war. Thomas headed the military department of Tennessee after the war and in 1869 was given command of the Division of the Pacific. He died in San Francisco, Calif., May 28, 1870.

T. R. H.

**THOMAS, NORMAN MATTOON** (1884- ), six times Socialist Party candidate for president of the United States, was born in Marion, Ohio, on Nov. 20, 1884, the son of a Presbyterian minister. He was graduated from Princeton University in 1905, and from Union Theological Seminary in 1911. In 1931 he resigned from the ministry. Thomas opposed America's entrance into World War I. After the outbreak of the war, he joined the Socialist Party and became founder and editor of *World Tomorrow* (1918-1921) and secretary of the Fellowship of Reconciliation. In 1921 he served as associate editor of *The Nation,* and in 1922 he was appointed co-executive director with Harry W. Laidler of the League for Industrial Democracy. Thomas was nominated for governor of New York on the Socialist ticket in 1924 and for president in 1928, 1932, 1936, 1940, 1944, and 1948. He opposed America's drift toward World War II, but following Pearl Harbor he supported the war. He lost the leadership of the Socialist Party at its convention in June 1950. His writings, which encourage the need for democratic socialism while voicing opposition to Russian Communism and totalitarianism, include *America's Way Out* (1930), *As I See It* (with Paul Blanshard) (1932), *Human Exploitation* (1934), *Socialism on the Defensive* (1938), *We Have a Future* (1941), *What is Our Destiny?* (1944), *Appeal to the Nations* (1947), *A Socialist's Faith* (1951), and *The Test of Freedom* (1954).

H. W. L.

**THOMAS, SETH** (1785-1859), American clock manufacturer, was born in Wolcott, Conn., Aug. 19, 1785. He was apprenticed early to a joiner, learned cabinet making, and finally, in 1807, entered the clock business when he began

SETH THOMAS

FROM AN ENGRAVING BY J. A. J. WILCOX

CULVER SERVICE

to work for Eli Terry in Greystone, Conn. In 1810 Thomas and Silas Hoadley formed a partnership to make tall wooden-movement clocks. Thomas sold out his interest to Hoadley in 1812 and moved to Plymouth Hollow, Conn. There he founded what became the Seth Thomas Clock Company and began to produce wooden-movement clocks by mass-production methods. Thomas was not an inventor nor an innovator; his success was due rather to a shrewd business acumen. After Eli Terry had secured a patent in 1814 for his shelf clock, Thomas paid Terry $1,000 for the right to use the patent for his own production. Thereafter Thomas produced many kinds of shelf clocks, changing designs as styles changed. All were powered with wooden movements until 1838, when Chauncey Jerome produced a brass movement which Thomas adopted. By 1850 he was making spring-driven clocks. In 1853, with a capital of $75,000, he organized the Seth Thomas Clock Company, which, after his death, was carried on by his son, Seth Thomas. Thomas' grandson and great-grandson, both also named Seth Thomas, later managed the company. Thomas died in Plymouth Hollow (now Thomaston), Conn., Jan 29, 1859.

B. P.

**THOMAS, SIDNEY GILCHRIST** (1850-1885), British metallurgist, was born in London in 1850. Educated at Dulwich College, he was expected to study medicine, but his father's death forced him to leave college. He entered the civil service, devoting his spare time to the study of metallurgy. He qualified for entrance to the School of Mines, but was financially unable to undertake the three-year program. During his studies he conceived the idea of using a strong

base to eliminate the phosphorus which gave serious trouble in the Bessemer steelmaking process. Building a miniature Bessemer converter, he experimented with furnace linings, but became convinced that large-scale operation was necessary. With the co-operation of P. C. Gilchrist he succeeded in dephosphorizing steel in the Bessemer process in 1875 and in 1878 prepared a paper with Gilchrist on his work. It took several years of tireless effort and discouraging failures to make the process commercially successful. Thomas was broken in health when the method had just begun to show the results that have made the Thomas-Gilchrist process the basic open-hearth method of steel production. He died at Paris on Feb. 1, 1885. R. S. Wi.

**THOMAS A KEMPIS** [ə kɛ′mpɪs] (c. 1380-1471), German priest, educator, and reputed author of *De Imitatione Christi (Of the Imitation of Christ),* was born Thomas Hamerken or Hämmerlein. The name by which he is known is a Latin school title, derived from the town of Kempen, near Düsseldorf, where he was born about 1380. He was educated at Deventer in Holland at a school of the Brothers of the Common Life, an association newly founded by Gerhard Groote. At the age of twenty he entered the neighboring monastery of Zolle, which had been established under the inspiration of Groote to act as the spiritual center of his association. Here, except for a few short intervals, he resided until his death at the age of ninety-two, employing his talents, in hours not given to prayer, in copying manuscripts, teaching, administration, and literary composition.

Whether Thomas a Kempis composed the *Imitation of Christ* or was merely the copyist responsible for the earliest manuscript containing the complete text is the subject of a long-standing controversy. From about 1600 until 1900 authorship was sometimes attributed to Jean Charlier de Gerson, a famous theologian contemporary with Thomas. This theory had scarcely been abandoned when a new claimant was put forward in the person of his contemporary Gerhard Groote. Whoever the author of the treatise may have been, he seized on the essential spirit of Christianity as an inner life, and expressed it with a nobility and charm to which few men can remain insensible. The book has been the vade mecum of most of the saints of the modern era. It has won admiration from persons of widely divergent religious views, including Samuel Johnson, John Woolman, George Eliot, and Matthew Arnold. Some have recognized in it an answer to a fundamental need of the human heart, that of finding inward peace through self-knowledge, self-discipline, and generous love. J. A. Sl.

**THOMASTON,** a city in west central Georgia, the county seat of Upson Co., located about 60 mi. south of Atlanta. It is served by the Central of Georgia Railway. In the fertile rolling countryside general farming and cattle raising are carried on, and the chief agricultural product is peaches. Local manufactures include a variety of textiles and tire fabrics. Thomaston, settled about 1825, was incorporated in 1872. The city government is administered by a mayor and council. Pop. 1950, 6,580.

**THOMASVILLE,** a city in southern Georgia, the county seat of Thomas Co., located 200 mi. south of Atlanta. Thomasville was founded in 1823 and incorporated three years later. It has the council-manager form of government. It is a popular winter resort, one of the first noted vacation spots in the South, and the city's rose gardens attract many visitors. Thomasville is the seat of the Vashti Industrial School for girls and of a veterans' hospital. The Atlantic Coast Line Railroad provides transportation. The county's largest income is derived from farming, with tobacco, peanuts, and truck crops the chief produce. Lumbering is also important in this yellow-pine district. Thomasville's chief industrial plants manufacture cotton thread, wearing apparel, food products, and crates and baskets. Pop. 1950, 14,424.

**THOMASVILLE,** a city in Davidson Co., in west central North Carolina, in the fertile Piedmont section of the state, located 18 mi. southeast of Winston-Salem. Founded in 1852 and incorporated in 1854, the city has the council-manager form of government. There is a Baptist orphanage in the city, which has transportation facilities provided by the Southern and the High Point, Thomasville & Denton railroads. An industrial city, Thomasville has large cotton and hosiery mills and furniture factories. Pop. 1950, 11,154.

**THOMPSON.** *See* INDIAN TRIBES, NORTH AMERICAN (*Plateau*).

**THOMPSON, ERNEST SETON.** *See* SETON, ERNEST THOMPSON.

**THOMPSON, FRANCIS** (1859-1907), English poet, was born at Preston, Lancashire, on Dec. 16, 1859, the son of Charles and Mary Thompson, both converts to Roman Catholicism. In 1864 the family moved to Ashton-under-Lyne, near Manchester, and this was Thompson's home until 1885. He recalled his childhood as painful, but he seems to have had hours of contented leisure, during which he read Scott, Coleridge, and Shakespeare. In 1870 he entered

*FRANCIS THOMPSON*

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Ushaw Seminary, Durham, where his shyness and frail body brought upon him the ridicule of his schoolmates; in 1874 he transferred to Ushaw College to study for the priesthood, but when he graduated in July 1877 the president of the school wrote that Thompson's "nervous timidity" unfitted him for that calling. Despite his increasing interest in poetry, he acceded to his father's urging to study medicine at Owens College, Manchester. A severe fever in 1879 was possibly the occasion of his first taking laudanum, and after six years of failure at Owens he fled to London in November 1885, where he lived for two years in great poverty.

From a life of match selling, cab calling, and laudanum drinking he was rescued by Wilfrid Meynell, editor of *Merry England,* who was impressed with poems sent him for publication and who, after long delay, sought him out in the

spring of 1888. Meynell helped him to regain partial health and published in *Merry England* his essays and poems, notably *The Hound of Heaven* (1890). Although Thompson still suffered from occasional depression, he was moderately happy during the rest of his life under the affectionate care of the Meynells and earned a modest living by journalism. In 1893 he published his *Poems,* on which his fame chiefly rests; this volume was followed by *Sister Songs* (1895), *New Poems* (1897), and a prose work, *Health and Holiness* (1905). His famous essay on Shelley (1889) was posthumously published in 1908. Thompson died of tuberculosis in London on Nov. 13, 1907.

Thompson's poetry, uncritically acclaimed and condemned when it appeared, "seethes with imagery," as its author said, and is an odd combination of Shelley and Crashaw, with touches of Coleridge, De Quincey, and, in late poems, Coventry Patmore, his friend. What it lacks in form and restraint is compensated for by its "full stream." Though Thompson could write simply and tenderly, his verse is most original when it is most turbulent, fantastic, and involuted. He has been called a mystic, a term he shunned; but he might be called, simply and properly, a religious poet, of narrow but splendid talent. L. A. C.

**THOMPSON, JOHN TALIAFERRO** (1860-1940), American soldier and inventor, was born in Newport, Ky., Dec. 31, 1860. He graduated from West Point in 1882 and after attending army schools entered the Ordnance Department in 1890. He retired from active service in 1914 as a colonel of ordnance. When the United States entered World War I, Thompson was recalled to active duty as chief of the Small Arms Division of the Ordnance Department. He was promoted to brigadier general in 1918 but at the end of the war retired once again and entered private business.

During his years of active service Thompson invented a number of semiautomatic rifles for both the standard .30-cal. cartridge and the .276-cal. Pederson cartridge, but none of these rifles proved successful. In 1920, however, the Thompson machine gun, or "Tommy gun," was developed and put on the market. This was a .45-cal. submachine gun, weighing about 10 lb., with full automatic or semiautomatic fire, and was among the first of its type to be made in the United States. The first military use of the gun was by United States Marines in Nicaragua in 1925. The gun was used in South America and China in the 1930's and a modification was adopted for the use of the United States and its allies during World War II.

In his last years Thompson devoted much time to the development and sale of his submachine gun. He died at Great Neck, Long Island, N. Y., June 21, 1940. R. W. Cr.

**THOMSON, ELIHU** (1853-1937), American inventor, was born in Manchester, England, on Mar. 29, 1853. His parents brought him to the United States when he was five years old, and after his education he taught chemistry and mechanics in a Philadelphia high school. In 1880 he went to work as an electrician in New Britain, Conn., and there began a series of important researches into the electric arc. With Edwin James Houston, an electrical engineer, Thomson in 1881 developed a practical system of arc lighting that was used extensively. In 1883 he and his collaborator organized the Thomson-Houston Electric Company in Lynn, Mass. This company was merged in 1892 with the Edison Company to form the General Electric Company, the world's largest manufacturer of electrical equipment. Thomson remained in charge of the laboratories at Lynn and was responsible for many notable advances in electrical engineering. In 1886 he invented the incandescent method of electric welding. Thomson also contributed to the successful development of the alternating-current motor. In 1890 he constructed the first high-frequency dynamo and soon thereafter developed the first high-frequency transformer. During his lifetime Thomson obtained patents on more than seven hundred inventions, including the centrifugal cream separator, the watt-hour meter, and important developments in radiology. He died in Swampscott, Mass., on Mar. 13, 1937. G. Q.

**THOMSON, JAMES** (1700-1748), English poet and dramatist, was born at Ednam in Roxburghshire, Scotland, probably on September 7, 1700, and died at Richmond in England, August 27, 1748. He attended Grammar School at Jedburgh, and later entered Edinburgh University in 1715 where, from 1719 to 1725, he studied divinity in preparation for the Presbyterian ministry. Finding the study of theology distasteful, he went to London in 1725, where he became the friend of Gay, Arbuthnot, Pope, and other men of letters. His small earnings as a tutor and the sinecures and pensions he enjoyed later through the patronage of influential persons, including the Prince of Wales, assured him leisure to devote to his writings. A juvenile poem, *Of a Country Life,* had early revealed Thomson's sensitiveness to rural scenery and his sincere love of nature. His first important nature poem was *Winter* (1726), the unexpected success of which in an age primarily concerned with poetry urban in quality and theme and done in polished heroic couplets led to the publication of *Summer* (1727), *Spring* (1728), and *The Seasons,* including *Autumn* and a *Hymn on the Seasons* in 1730. A greatly expanded and rewritten edition of *The Seasons* appeared in 1744. In addition to *The Seasons* and to certain juvenile and miscellaneous poems that merit no mention, Thomson wrote *A Poem Sacred to the Memory of Sir Isaac Newton* (1727), an understanding and genuine tribute to the great scientist who had died that year; *Liberty* (Parts I, II, III, 1725; IV, V, 1736), a blank-verse poem, stilted in form and prolix in praise of the Goddess of Liberty, yet showing an early poetic treatment and appreciation of architecture and sculpture; and *The Castle of Indolence* (1748), an allegory done in Spenserian stanzas that imitate aptly the melodic manner and sensuous imagery of Edmund Spenser. Thomson's dramatic works, *Sophonisba* (1730), *Agamemnon* (1738), *Edward and Eleonora* (1739), *Alfred: A Masque* (with David Mallet or Malloch, 1740), and *Coriolanus* (posthumously produced in 1749), are memorable examples of the low ebb of dramatic taste and achievement during the period. They purport to be tragedies, and most of them have contemporary political implications. *Alfred* contained the patriotic lyric *Rule, Britannia.*

*The Seasons* is Thomson's major work and the most important nature poem of the pre-Romantic period. Its Latinized diction, the Miltonic quality of the blank verse, the idyllic scenes portrayed, the rhapsodic style in many passages, the excursive flights of fancy to polar and torrid regions, the sentiments concerning benevolence and humanitarian themes, the scientific interpolations, and the philosophic bias reveal Thomson as an eclectic poet who drew inspiration from many sources. Though not a Romantic poet himself, Thomson's sensitive and enthusiastic treatment of nature and the comman man, his often precise descriptive phrasing, and his imaginative treatment of subject, coupled with a sincere effort to achieve emotional effect, show him to be the most significant harbinger of the Romantic Movement in English literature. H. Dr.

**THOMSON, JAMES** (1834-1882), British poet and journalist, was born in Port Glasgow, Scotland, Nov. 23, 1834. He was educated for a teaching position and in 1851 became assistant army schoolmaster at Ballincollig in southwestern Ireland. There he formed a friendship with Charles Bradlaugh, the social reformer, and fell in love with Matilda Weller, whose death in 1853 caused him severe grief. He taught school at several posts between 1854 and 1862, observed much outdoor life, and read widely before he was discharged from the army on slight grounds. Bradlaugh then helped him to become a solicitor's clerk and a journalist. Thomson's contributions to the *National Reformer* included *To Our Ladies of Death* (1861) and *The City of Dreadful Night* (1874), the latter praised by George Eliot and George Meredith. In 1869 his *Sunday up the River,* which contained "Give a man a horse he can ride," appeared in *Fraser's Magazine.* From 1866 until his death he occupied single lodgings in London, except for a short trip in 1872 to Colorado, where he represented the stockholders of a mining company, and one in the following year to Spain as war correspondent. After suffering the afflictions of alcoholism, poverty, and depression during the remainder of his life, he died June 3, 1882, in University College Hospital, London.

Thomson adopted the pen name "B. V." (for "Bysshe Vanolis") in honor of Shelley and Novalis. His work, which is at times cheerful, is predominantly somber. Much of his prose and verse was collected posthumously, but *The City of Dreadful Night and Other Poems* was published in 1880 with the aid of Bertram Dobell. Thomson's masterpiece, the title poem of that collection, symbolizes the world as a city empty of life except for a few doleful wretches over whom presides Melancholia, the embodiment of utter pessimism. It is compelling in its imagery, sonorousness, and sustained gloom. W. D. T.

**THOMSON, SIR JOSEPH JOHN** (1856-1940), British physicist, was born near Manchester, England, on Dec. 18, 1856. He was educated at Owens College, Manchester, and Trinity College, Cambridge. Soon after his graduation from the latter he began a lifelong association with Cambridge University, where, as Cavendish Professor, he made important contributions to nuclear physics. A brilliant study of the cathode rays, which Thomson announced in 1897, led to the discovery that the electron is a body smaller than the hydrogen atom and that electrons are to be found in all matter. Thomson also devised a new way of separating different kinds of atoms and molecules, and his researches paved the way for the discovery of various isotopes. For his studies of the conduction of electricity through gases, Thomson was awarded the 1906 Nobel Prize for physics. He became master of Trinity College in 1918, a post he held until his death in Cambridge on Aug. 30, 1940. Thomson's most important writings were *The Application of Dynamics to Physics and Chemistry* (1888), *Elements of the Mathematical Theory of Electricity and Magnetism* (1895), *Rays of Positive Electricity* (1913), *The Electron in Chemistry* (1923), and *Recollections and Reflections* (1937). G. Q.

**THOMSON, VIRGIL** (1896- ), American composer and critic, was born in Kansas City, Mo., Nov. 25, 1896. He was educated at Harvard University and later studied with Nadia Boulanger in Paris, where he lived from 1925 to 1932. He was critic for the New York *Herald Tribune,* 1940-1954. Among Thomson's best-known compositions are the two operas on librettos by Gertrude Stein, *Four Saints in Three Acts* (1934) and *The Mother of Us All* (1947); a ballet, *The Filling Station* (1938); and the incidental music for the documentary films *The Plow That Broke the Plains* (1936), *The River* (1937), and *Louisiana Story* (1948). E. L. F.

**THOMSON, WILLIAM.** *See* KELVIN OF LARGS, BARON (WILLIAM THOMSON).

**THOR** [thɔ'r], in Scandinavian mythology, the god of thunder and son of Odin and Jord. His wife was Sif. His widespread cult is attested by the equally widespread use of his name for the fifth day of the week, Thursday, among the Teutonic peoples. Thor is represented as a man of fabulous strength, red-bearded, and riding in a goat-drawn chariot which caused the thunder by its rolling. He was popular as the benevolent friend and protector of men. Thor's three precious possessions were the girdle of strength, iron gloves, and the magic hammer, Mjollnir, with which he slew the giant demons and which returned to him like a boomerang (the thunderbolt). Thor is identified with Jupiter and with the Anglo-Saxon god Thunor or Thonar. C. W. D.

**THORACIC SURGERY.** *See* SURGERY.

**THORBORG, KERSTIN** [tu'rbɔry] (1906- ), Swedish operatic contralto, was born at Venjan, Dalekarlia, May 19, 1906. She appeared at the Royal Opera, Stockholm; at Covent Garden, London; at the Colon in Buenos Aires; and in Vienna, Salzburg, Berlin, Prague, and Munich. She made her American debut at the Metropolitan Opera House, New York City, Dec. 21, 1936, as Fricka in *Die Walküre.* She remained on the roster of the Metropolitan until 1946. Her Metropolitan roles included Fricka, Erda, and Waltraute in the *Ring* cycle, Ortrud in *Lohengrin,* Magdalena in *Die Meistersinger,* Brangäne in *Tristan und Isolde,* and Venus in *Tannhäuser.* In 1938 she sang Klytemnestra in the Metropolitan's revival of Richard Strauss's *Electra* and Octavian in his *Rosenkavalier.* In Europe she sang the title role in his *Salome.* F. G. P.

**THOREAU, HENRY DAVID** [thɔ'ro] (1817-1862), American essayist and poet, was born July 12, 1817, in Concord, Mass., of mixed Scottish and Huguenot ancestry. After preparing at the Concord Academy, he entered Harvard in 1833 and graduated four years later; at Harvard his participation in college activities was limited, but he read widely in poetry, particularly that of the seventeenth century. After his graduation, he and his brother John conducted a successful private school until the latter's death in 1841. Grief over this loss, the most poignant that Thoreau ever experienced, led him directly to the writing at Walden of his first book, *A Week on the Concord and Merrimack Rivers* (1849). Based upon a journey taken by the brothers in 1839, but drawing heavily upon the voluminous journals which Thoreau began keeping after he left college, the narrative is obscured by discursive, essaylike observations, and as a result, though it is occasionally charming, the book was understandably neglected. At the same time, however, this first effort gives evidence of Thoreau's reading in the Oriental scriptures, which he had begun at Emerson's suggestion at about the time of the journey, and of his growing sympathy with Emerson, Bronson Alcott, and other members of the Concord Transcendental group. It also shows his interest in Alcott's *Conversations,* begun in 1840, and in *The Dial,* launched in the same year; to the latter Thoreau contributed translations, an essay, and several poems, and in addition he assisted in its management. His lectures in Concord and

neighboring towns also reflected his interest in the Transcendentalist movement.

On July 4, 1845, Thoreau entered upon the most significant single experience of his life, his residence at Walden Pond. Fond of nature from childhood, he undertook the experiment with two avowed purposes: to determine to what extent life could be stripped of non-essentials and driven "into a corner," and to accomplish certain private tasks of a literary nature. To this may be added an unacknowledged need for peace from certain personal losses. This episode, although it lasted for only twenty-six months and was interrupted in 1846 by the visit to Maine, bore fruit in Thoreau's most memorable work, *Walden,* or *Life in the Woods* (1854). Treasured by lovers of nature for its detailed and perceptive descriptions of the phenomena of the seasons, of the physical aspects of the region, and of its flora and fauna, this book is also filled with trenchant social criticism and is generally regarded as one of the classics of American literature.

HENRY DAVID THOREAU

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Records of Thoreau's travels within and outside New England are to be found in *Excursions* (1863), *The Maine Woods* (1864), *Cape Cod* (1865), *A Yankee in Canada, with Anti-Slavery and Reform Papers* (1866), and in F. B. Sanborn's *The First and Last Journeys of Thoreau* (1905). An ardent enemy of slavery, Thoreau deplored the Mexican War, opposed the return of fugitive slaves, and defended John Brown; three of his addresses—*Civil Disobedience* (1848), *Slavery in Massachusetts* (1854), and *A Plea for Captain John Brown* (1859)—indicate the strength of his feeling on these subjects. To active association with his father in pencil-making he joined a knowledge of surveying and a New England readiness at handiwork. His capacity for friendship was considerable, some of his most intimate friends being Emerson and Mrs. Emerson, Nathaniel Hawthorne, and especially Ellery Channing. His death, which occurred in Concord on May 6, 1862, caused grief to many, not only among the Transcendental circle, but among neighbors and children in particular, who found him always ready for a ramble in the woods. He was buried in Sleepy Hollow Cemetery, Concord. B. V. C.

**THORGILSSON, ARI (FRÓDI) THE LEARNED** [thɒ′rgɪlsɒn] (1067-1148), Icelandic historian, was born in West Iceland in 1067 and lived in Haukadalr, a seat of learning in southern Iceland. Ari is the father of Icelandic saga writing, which to him meant historiography. Only an abridgment of Ari's *Íslendingabók* ("Book of Icelanders") (c. 1122-1133) survives; the complete work contained genealogies and kings' lives omitted in the abridgment. Influenced by eleventh-century chronicles, Ari was a painstaking chronologist, but he could also tell a good story. Probably he had something to do with the *Landnámabók* ("Book of the Land-taking"), a unique genealogical-geographic work, which enumerates approximately four thousand early settlers of Iceland. S. E.

**THORIUM** [tho′riəm], symbol Th, atomic number 90, at. wt. 232.12, density 11.2, m.p. 1,845° C., b.p. over 3,000° C. Thorium, named for Thor, the Norse god of war, is the second member of the Actinide series in the periodic table which includes elements numbers 89 through 98. Thorium is a transition element having an atom which contains five completed shells of electrons (2, 8, 18, 32, 18), a sixth, incomplete shell of 10, and an outer shell of 2. It is a heavy gray metal, slightly malleable and ductile, magnetic, and radioactive; it burns brilliantly when heated in air, is soluble in concentrated hydrochloric acid and aqua regia, and is not attacked by alkalies. In all its compounds, thorium is quadrivalent; its solutions are colorless. The oxide, $ThO_2$, used as a catalyst and in incandescent gas mantles with cerium dioxide, has been called the most refractory substance known. Thorium nitrate, $Th(NO_3)_4$, a white crystalline salt readily soluble in water, is also of industrial importance. The possibility of producing fission, as in uranium, has greatly increased interest in thorium and its compounds. B. S. H.

**THORNDIKE, EDWARD LEE** (1874-1949), American psychologist, was born at Williamsburg, Mass., on Aug. 31, 1874. He was educated at Wesleyan, Harvard, and Columbia universities. After a year as instructor in education and teaching at Western Reserve University, he went to Teachers College, Columbia University, where he taught until his retirement in 1941.

Thorndike was in no small way responsible for opening the way for education to develop a scientific foundation, starting with his early books, *Educational Psychology* (1903), *Mental and Social Measurements* (1904), and *The Principles of Teaching* (1905). His primary interest in the learning process in children, adults, and even animals was made evident in such later writings as *Animal Intelligence* (1911) and *The Origin and Nature of Man* (1913). His *Psychology of Learning* (1914) is a basic work on the process of learning. During World War I, Thorndike was chairman of the Committee on Classification of Personnel in the United States Army. His methods of psychological measurement employed there set the pattern for personnel placement and vocational and educational guidance, as is shown in the continued wide use of his many tests and scales. *The Measurement of Intelligence* (1926), along with many articles and studies, represents this major area of his interest. In *Adult Learning* (1928) he turned his attention toward the mature individual. *The Fundamentals of Learning* (1932), perhaps his most important published work, is a scholarly review of his own experience on the subject of learning. In *Your City* (1939) he turned to adult learning in community living and criticized many of the so-called good influences in city life. Among his last books are *Human Nature and the Social Order* (1940) and *Man and His Works* (1943). Thorndike died on Aug. 9, 1949, in Montrose, N. Y. A. W. S.

**THORNY DEVIL.** *See* MOLOCH.

**THOROLD** [thɔ′rold], a town in Welland Co., Ontario, Canada, located 7 mi. west of Niagara Falls at the point where the Welland Ship Canal climbs the Niagara Escarpment by means of the great Twin Flight Locks. Thorold was founded by United Empire Loyalists before 1800; it was incorporated as a village in 1850 and as a town in 1874. Many industries have been attracted by the canal and the abundant hydroelectric power of the district. Articles manufactured in Thorold include pulp, paper and paper products, steel products, tools, dies, machinery, abrasives, and firebrick. The town is served by the Canadian National and the Niagara, St. Catharines and Toronto railways. Pop. 1951, 6,397.
D. F. P.

**THORPE, JAMES FRANCIS** (1888-1953), American athlete, was born near Prague in the Indian Territory (now Oklahoma) on Mar. 28, 1888, of mixed Irish, French, and Indian ancestry. He attended the Haskell Institute at Lawrence, Kans., and the Carlisle Indian School at Carlisle, Pa., where in 1907 his athletic abilities attracted the attention of Glenn S. "Pop" Warner, famous athletic coach. Thorpe soon became an outstanding athlete and starred at football in 1908. In 1909 he went south under Carlisle direction to do farm work and in the summers of 1909 and 1910 played professional baseball with various minor league clubs in the south, a common practice with collegians of that day. In 1911 he returned to Carlisle. His feats on the football field that year and the next as he led little Carlisle to victories over the best teams in the country have become part of football legend, and in both 1911 and 1912 he was named to Walter Camp's All-American team.

In the summer of 1912 Thorpe won both the pentathlon and the decathlon in the Olympic Games at Stockholm, the only time such a double victory was ever achieved in the Olympics. He won four of the five pentathlon events, broke all scoring records in the ten-event decathlon, and established himself as the greatest all-around athlete of his day. In January 1913 the Amateur Athletic Union, discovering that Thorpe had played professional baseball, deprived him of his amateur status and forced him to return his Olympic medals and trophies. Thorpe admitted that he had played professionally, but pleaded that he did not realize that such action would bar him from future amateur competition.

Thorpe left Carlisle in 1913 and played major-league baseball with the New York Giants, Cincinnati Reds, and Boston Braves until 1919. He also played professional football and in 1920 became the first president of the American Professional Football Association (later the National Football League). He played with the Canton Bulldogs, the New York Giants, and other clubs before retiring in 1929 at the age of 41. Thereafter, he occasionally appeared with carnivals, on lecture platforms, or in motion pictures. In World War II, when he was past 50, he served with the Merchant Marine. Thorpe died on Mar. 28, 1953, in Lomita, Calif. An Associated Press poll in 1950 named him the greatest football player and the greatest all-around athlete of the twentieth century.
R. W. Cr.

**THORVALDSEN, BERTEL** [tʊ′rvalsən] (1770-1844), Danish sculptor, was born in Copenhagen on Nov. 19, 1770, the son of an Icelandic ship's carpenter and carver who had emigrated to that city. The young Thorvaldsen studied at the Danish Academy of Art from the age of eleven, obtained a traveling scholarship in 1792, and in 1797 went to Rome, where he remained throughout most of the rest of his life.

Although often called phlegmatic and uninspired, Thorvaldsen earned recognition as one of the leading figures of the then thriving neoclassic movement. He emphasized the importance of Greek art as the basis of Classic style and prided himself on his authentic imitation of it, but his work most nearly resembles the general neoclassic product, and its particular Hellenism is evident mainly only in the predominance of Greek subjects and the adaptation of Greek originals, as in his *Jason,* which he based on the *Apollo Belvedere.* In his equestrian statue of the Polish patriot, Prince Józef Antoni Poniatowski, he closely followed the late Roman statue of Marcus Aurelius.

Thorvaldsen was commissioned by Count Ludwig of Bavaria to restore the pediment sculptures of the early Greek temple at Aegina; he is also known for the *Lion of Lucerne,* carved in living rock. Interested in style rather than craft, Thorvaldsen developed the practice of modeling his compositions and having them carved by studio assistants. He returned to Denmark in 1838, with the completed colossal statues of Christ and the twelve Apostles for which he had been commissioned; he died in Copenhagen Mar. 24, 1844.
L. R.

**THOTH** [tho′th; to′t], the scribe of the gods in the religion of ancient Egypt. He was also noted as measurer of time, inventor of numbers, and mediator between Horus and Set, from which arose his reputation as a god of wisdom. Though portrayed in the form of a baboon, he received honors from the Pharaohs. In the judgment hall of Osiris, Thoth recorded the results when hearts were weighed.

Originally a moon god, in the Osiris myth Thoth represented Horus and his allies, and, above all, Set and his partisans. Thoth was usually drawn with the head of an ibis or as a cynocephalus. The Greeks identified him with Hermes (Mercury). Above all other Egyptian deities, Thoth created through his words, and, in the Mystery Play of the Succession, typical Egyptian words of deception are put into his mouth. In Hermopolis, center of his worship, he appeared at times to take personal initiative in creative acts; at other times he was merely an instrument of the creator.

As divine scribe, Thoth figured in the coronation ceremonies. According to inscriptions, during her crowning, Hatshepsut (c. 1495-1480 B.C.) was addressed by Thoth in these words: "I establish for thee then thy crown." A prayer to Thoth, dating from the thirteenth century B.C., opens with a touch of simple piety: "Thoth, thou sweet fountain for one who thirsteth in the desert." Thus, Thoth of Hermopolis, who became private scribe to the supreme deity, Ra, acquired a place in the cosmic scheme.
E. J. J.

**THOUSAND AND ONE NIGHTS, ONE.** *See* ARABIAN NIGHTS, THE.

**THOUSAND ISLANDS,** a group of about 1,700 small islands almost blocking the St. Lawrence River where it leaves Lake Ontario. Some of the islands belong to the United States (New York State), and some to Canada (Province of Ontario). Geologically, they are part of a wide strip of granite rock, a prolongation of the Canadian Shield, which links the "Frontenac uplift" of Canada to the Adirondack Mountains in the United States. The largest islands are Wolfe, 18 mi. long, and Howe, both in Ontario; and Grindstone and Wellesley, in New York. The Thousand Islands International Bridge, opened in 1938, connects Collins Landing in New York with Ivy Lea in Ontario. The islands are a popular resort.
G. T.

**THOUSAND-LEGGED WORM,** the common name given to the millepedes and sometimes erroneously to the centipedes. *See also* MILLEPEDE.
W. I.

**THRACE** [thre's], the ancient name of a Balkan area bounded on the north by the Danube River, on the east by the Black Sea, on the south by the Aegean Sea, and on the west by the Strimón River. This wild and rugged territory was inhabited by fierce and warlike tribes, the Thracians, who resisted conquest by the civilized countries of the Classical period. The rough, wooded topography made military operations difficult, and, while the Thracians lacked an organized government, they withstood inroads by the Persians, Greeks, Macedonians, and Romans. It was not until A.D. 46 that Thrace became a Roman province, although it had been a client kingdom in the reign of Augustus. The primitive culture was reflected by the historian Herodotus, who recorded the presence of lake dwellers in the fifth century B.C., one thousand years after the lake cultures of Switzerland and northern Italy had disappeared. The river settlements of Adrianople (now Edirne) and Philippopolis (now Plovdiv) were the only large towns during the Roman period. T. B. J.

**THRACIAN** [thre'shən], an apparently Indo-European language of the satem type formerly spoken in the eastern part of the Balkan Peninsula, in ancient Moesia (now Bulgaria), and Dacia (now Romania). Its Indo-European nature is indicated by words like Σεμέλη (the Greek goddess of Thracian origin), which is comparable to Russian *zjemljá,* Latin *humus,* and Greek *χθών, χαμαί*; Βετ-έσπιος, or Οὐτ-άσπιος, the name of the Thracian equestrian hero, comparable to Latin *equos* and Vedic *áśva-s;* Ρῆσος, the name of a Thracian king, perhaps to be compared to Latin *rex, regis and* Vedic *rájā* (king); and δίζος, δίζα ("fortress"), comparable to Greek τεῖχος, Latin *fingo,* German *teig,* English *dough,* and others.

Thracian is known through personal names, the most typical being those ending in *-centus, -poris* and *-tralis,* and place names, many of which end in -διζος or -διζα, *-deua* or *-daua,* and *-bria.* There is only one Thracian inscription in Greek characters, perhaps a hexameter, found on a ring at the Bulgarian village of Ezerovo near Plovdiv (Philippopolis); but its interpretation is very uncertain. Thracian is very closely connected with Phrygian and Armenian on one side and with the Slavic languages on the other; it is perhaps the direct ancestor of Albanian, which is also a satem language. The pre-Roman substratum of Romanian was also probably Thracian, for Dacian was very probably a Thracian dialect. G. B.

**THRASHER,** any one of a number of species of medium-sized (9-12 in.) American songbirds combined in the genus *Toxostoma* of the family Mimidae. They are allied to the mockingbirds and catbirds. They range from southern Canada to southern Mexico. Thrashers are characterized by a long, slender curved bill, short wings, and a long tail; their plumage is mainly shades of brown or gray, and some species have the under parts conspicuously streaked with black. They inhabit brushy country and are usually somewhat retiring birds, although they may mount to an exposed perch to sing. Their notes are melodious and scarcely inferior to those of the mockingbirds. The brown thrasher, *T. rufum,* of eastern North America is foxy red-brown above, white below, with heavy black streaks; it is common almost everywhere west to the Rocky Mountains. In the western states many other thrashers occur, of which some are difficult to distinguish. Among the best known are the California thrasher, *T. redivivum,* brown above and buff beneath; the curve-billed thrasher, *T. curvirostre,* brownish-gray above and white with brownish-gray spots beneath; and the crissal thrasher, *T. crissalis,* similar to the last, but lacking the spots and having the under tail-coverts chestnut. H. G. De.

**THREADWORMS,** or whipworms, true nematode round worms of the phylum Nemathelminthes. They are widely distributed in mammals in the warm moist regions of the world. The human species, *Trichocephalus* (*Trichuris*) *trichiura,* is found in the cecum, appendix, and colon regions of the intestine; it may be responsible for various gastrointestinal disturbances. Infection is established by ingesting eggs containing the infective larvae. The anterior three-fifths of this worm is drawn out into a whiplike process. The females may be 1½ to 2 in. long; the male is somewhat smaller, 1 to 1¾ in. R. F. N.

**THREE FATES.** *See* FATES.

**THREE HOURS' AGONY.** *See* GOOD FRIDAY.

**THREE-MILE LIMIT,** the jurisdiction of a coastal state extending to the open sea a distance of three miles measured from low tide. In international law it is often called the marginal sea. The three-mile limit became generally recognized after the publication of Cornelis van Bynkershoek's *De dominio maris* in 1702, in which he established the principle that the territorial jurisdiction ends where the effective force of arms ends. The range of cannon of that day seems to have set a marine league, or three nautical miles, as the limit. A wider limit of jurisdiction is desirable and is sometimes maintained by courtesy or by treaty agreement. In 1930 a Conference for the Codification of International Law was held at The Hague, but no agreement was reached on a general convention on the territorial sea. It is generally agreed that the three-mile limit includes the air above the waters as well as the bed of the sea and its subsoil. H. B. C.

**THREE MUSKETEERS, THE.** *See* TROIS MOUSQUETAIRES, LES.

**THREE RIVERS,** a city in St. Joseph Co., in southwestern Michigan, situated at the confluence of the St. Joseph, Portage, and Rocky rivers, 23 mi. south of Kalamazoo. It was founded in 1830 and incorporated in 1895. Three Rivers is governed by a council and city manager. In the seventeenth century it was the site of a Jesuit mission. The community is served by the Michigan Central Railroad of the New York Central System. It is chiefly a manufacturing city, and its products include steam pumps, windmills, stokers, electric saws, paper containers, boxboard, and fur and woolen garments. Farms of the area are engaged in dairying and stock raising. Pop. 1950, 6,785.

**THREE SISTERS, THE** (*Tri Syestrai*), a three-act play by the Russian writer Anton Chekhov (1860-1904), first produced in 1901 by the Moscow Art Theatre.

Its main characters, Olga, Marya, and Irina, the sisters Prozorov, live with their brother, Andrei, in a provincial Russian town, whence they have come from Moscow to live with their widowed father, a general of the Russian army. Olga, the eldest, is a school teacher; Marya is the wife of a school teacher; and Irina, the youngest, feels she must work to make her life worth while.

Life in the town is drab and monotonous, the people backward and crude. Memories of their beloved Moscow, where all of them were born, haunt the sisters, and after their father's death the desire to go back to Moscow becomes

overwhelming. "To Moscow!" "To Moscow!" is the cry heard throughout the play. But unfortunate events prevent the fulfillment of their desire.

In Chekhov's plays there is almost no action, but there is a powerful evocation of mood. Thus, in *The Three Sisters* is found a profound sense of the sadness and tragedy of existence. Here are portrayed the Russian intelligentsia of the time—people without will and without firm ground under their feet, without a clearly defined purpose in life.

N. M. S.

**THREONINE.** *See* PROTEINS.

**THRESHER SHARK,** *Alopias vulpinus,* or fox shark, a large fish of the family Alopiidae, easily recognized by the long curved tail which exceeds the length of the head and body together. It is widely found in most temperate and tropical seas and is common in the Atlantic and Mediterranean. A fast-swimming giant that attains a weight of 1,000 lb. and a length of 20 ft., it sometimes uses its tail to obtain fishes for food. One or more thresher sharks will swim around a school of fishes, lashing the prey into a mass where they can easily be captured. They also have been observed throwing fish in or toward the mouth by a sweep of the tail. The thresher shark is a weak-toothed species harmless to man, and it is of little economic value. E. C. R.

**THRIFT,** a name often given the common sea pink, *Armeria maritima,* a low, tufted evergreen perennial of cool northern regions, cultivated in many varieties for its showy flowers. It grows to about 1 ft. in height. J. C. Wis.

**THRIPS,** the name given to insects of the order Thysanoptera. They are almost all minute creatures, of very slender build, less than 1/15 in. in length. The wings are very peculiar, being long and narrow with close-set hairs on both borders, which serve to increase the lifting area. Most of the thrips feed upon plant tissues, but some kinds are predaceous upon other thrips and small insects in general. A few have become so closely associated with the pollination of plants that they are almost essential in the production of fruit, but because of their small size and secretive habits, little is known about them. Parthenogenesis is common in the order; in the greenhouse thrips, *Heliothrips haemorrhoidalis,* and the pear thrips, *Taeniothrips inconsequens,* males are extremely rare. One of the most serious pests in the order, *Thrips tabaci,* the onion or tobacco thrip, causes enormous damage to many crops but is also important as a pollinator of various other plants. It is a general feeder. The very small eggs are laid on or in plant tissues and the young resemble the adults except for the fact that they are wingless. The largest known thrip is about ½ in. long. C. H. Cu.

**THROMBOSIS** [thrɒmbo′sis], the formation within a vessel of a thrombus, or blood clot. A thrombus may form in a vein or an artery, the former being the most usual location. The veins of the legs and anus are the most common locations. Other vessels frequently involved are the veins of the small intestine and the veins of the pelvis; less frequently, the portal vein and the main artery of the leg. When a thrombus forms in any artery of the heart, the resulting condition is coronary thrombosis.

Thrombosis frequently follows an operation, but occasionally occurs in nonoperated cases. An infection causes the blood to clot and to fill the vessel. Injection treatment for varicose veins produces a thrombosis, but by a chemical process. Thrombi, which form in arteries, occur on calcareous deposits in these vessels and are to be attributed to stasis, or stoppage of the blood flow.

The symptoms of thrombosis in the veins are pain, tenderness, swelling, and an elevated temperature. If the thrombi are located in the leg, the veins are palpable and tender. A thrombosis in the artery of the leg causes severe pain and the leg becomes blue and cold. When a blood clot breaks loose, it becomes lodged in other parts of the body and is known as an embolus. Treatment includes rest in bed, elevation of the leg, and chemotherapy. Many surgeons advise opening of the vein and removal of the clot. Clots in the artery should always be removed. W. H. B.

**THROOP,** a borough in Lackawanna Co., in northeastern Pennsylvania, situated northeast of and adjoining the city of Scranton. It is located in the anthracite fields, and coal mining is its chief activity. Throop was incorporated in 1894. The borough is governed by a mayor and council. A mine disaster in April 1911 took a toll of 72 lives. It is served by the New York, Ontario and Western Railway. Besides coal mines the principal industrial establishments are a silk mill and several garment factories. Pop. 1950, 5,861.

**THROUGH THE LOOKING GLASS,** a children's story, by Charles Lutwidge Dodgson (Lewis Carroll), published in 1872. Like its predecessor, *Alice's Adventures in Wonderland* (1865) this tale was originally devised to entertain the young daughter of Henry George Liddell, also named Alice. The Alice of the story, who climbs through a looking glass, finds a world where everyday actuality is bewilderingly reversed. The plot of the tale is her dream quest for her heart's desire, a search symbolized by the moves of a gigantic chess game culminating in her being crowned as queen. Freudians interpret the books as mirroring the contradictions and frustrations of its author. It has also been considered a satire upon contemporary society, Alice representing the sane observer of an irrational world. Some thought it a satire on logic itself. Another opinion emphasizes the element of humorous self-portrayal, in which Carroll himself figures chiefly as the pleasantly inept White Knight. The variousness of these interpretations indicates the rich power of suggestion and the subtle undercurrent of meaning with which this children's nonsense volume is endowed, even though the author never lapses into didacticism. Other beloved characters of the story are Tweedledum and Tweedledee, and "Jabberwocky" is probably the best known nonsense rhyme in the language.

R. H. Fo.

**THRUSH,** the name given to many species of small to medium-sized songbirds united in the subfamily Turdinae of the family Turdidae or insect eaters. Among them are such distinct types as the Asiatic forktails, the nightingales, the stonechats, and the Old World redstarts. The American representatives of this group range in size from the robin (10 in.) to the bluebird (7 in.). They are found in virtually all parts of the world, including the larger oceanic islands. Thrushes have few characteristics that serve to separate them from their near relatives, the warblers and the Old World flycatchers; yet to a trained eye most of them are immediately recognizable, if only by their shape and carriage. They usually have relatively long, slender bills and legs; their plumage may be pied, all black, mainly brown or gray, or almost any combination of bright colors. Their habitats are equally diverse: in all countries one species or another is likely to occur in every sort of terrain available. Thrushes feed chiefly on insects, but many take fruits and

HAL H. HARRISON

*A wood thrush and its young*

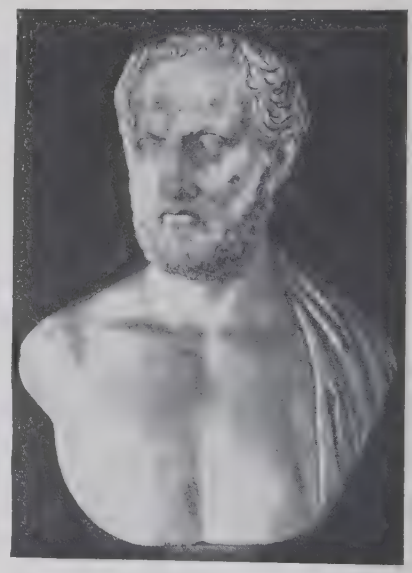
berries in season. As a group they are notable for their melodious voices, and some of them produce what is conceded by connoisseurs to be the sweetest bird music. Worthy of special mention in this respect are the shamas of the Asiatic tropics, the solitaires of the New World, the Eurasian nightingales, and the North American hermit thrushes.

H. G. De.

**THRYALLIS** [thraiæ′lɪs], any one of a group of small and rather woody shrubs, 1 to 2 ft. tall, cultivated in the southern United States and south to Brazil. They have yellow or reddish panicles of flowers. J. C. Wis.

**THUCYDIDES** [thyusɪ′dədiz] (c. 460-c. 399 B.C.), Athenian historian of the Peloponnesian War, was the son of Olorus, an Athenian citizen of the deme Halimus. The name Olorus had once been borne by a Thracian king whose daughter Hegesipyle had married the famous Athenian general Miltiades, and Thucydides may have been related to this family. This possibility is also indicated by the ancient tradition that the historian's tomb was located among the monuments of Cimon, the son of Miltiades, outside the Miletene gate on the way to the Piraeus. During his youth Thucydides knew the most glorious days of Athens, when the city achieved political and cultural supremacy under the leadership of Pericles. His admiration for this Athenian statesman is apparent throughout his *History of the Peloponnesian War* and especially in the famous funeral oration which he describes as having been given by Pericles, and is remarkable if one grants Thucydides blood ties with the family of Cimon, Pericles' bitter political foes.

Thucydides must have received the well-rounded education of the Athenian citizen of his day, not only in politics but also in literature and philosophy. It is doubtful, however, that he would have engaged in historical research had it not been for the Peloponnesian War. Although he probably did not write his account of this war until after 404, he began taking notes as early as 432 at the outbreak of hostilities between Athens and Sparta, and he was quick to realize the significance of this conflict. Thucydides is normally reticent about himself in the *History,* but he does relate that he was a victim of that plague (now identified as a virulent form of typhus) which devastated Athens in the early years of the war. His own military activities he relates in several chapters devoted to the Thracian campaign of 424 B.C. He was elected as one of the ten generals for that year and assigned to the Thracian area, where he probably had family connections through which he held mining property. In this campaign Thucydides was sent to relieve Amphipolis, then being besieged by the Spartans under Brasidas. He failed to raise the siege through no fault of his own, inasmuch as his force of only seven ships was scarcely adequate; but his lack of success was not taken lightly in Athens, and he was at once sent into exile. This separation from Athens for the next twenty years was not entirely unfortunate, however, for Thucydides was thus enabled to see the war from both sides. It can be deduced from his *History* that Thucydides returned to Athens and survived the war, but he did not live to finish the work he had projected. He described, in fact, only twenty-one of the twenty-seven years of the conflict. Nevertheless, although Thucydides slighted the intellectual and aesthetic heritage of the past in his interest in the development of power, his work is outstanding as the first genuine political history. It is characterized by a dispassionate, though somewhat cynical, point of view; for Thucydides' historical philosophy held that human nature is uniform and that man can foresee the future from a study of the past. A. E. R.



*THUCYDIDES*

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**THUG,** a hoodlum or murderer, originally a member of a community of professional assassins who flourished in northern India during the later Mogul period and were suppressed by the British in the second quarter of the nineteenth century. The Thugs did not constitute a single caste, but were drawn from several different castes. They lived in towns and villages and followed other occupations when not engaged in their practice of thuggee, or murder and robbery. The Thugs traveled in bands of from ten to fifty when they set out on a murderous robbing expedition. Always unarmed, gentle, and courteous in demeanor, they attached themselves to individuals or small parties of travelers, and sometimes traveled for days with their prospective victims, awaiting a convenient opportunity to strike. Three Thugs were usually assigned to one victim. When the signal was given, two grasped his arms and legs, the third strangled him with a running noose. The body was buried with dispatch and the booty collected. No adult in a party was ever allowed to survive, but children were sometimes spared and adopted into the group. An apprentice was taken on a number of expeditions before he was allowed to do the actual strangling. The Thugs considered their

victims as sacrifices to the Hindu goddess Kali, and after each murder the band participated in a sacrificial feast of raw sugar. It was forbidden to murder holy men, outcasts, and women. This last tabu was not strictly observed, and in the nineteenth century many Thugs attributed their capture by the British to the breaking of this tabu, refusing to believe that their murders in general might be a crime. E. E. B.

**THULE** [thyu'li], a land known to the ancients as the northernmost part of the inhabited world. It was given its name by the explorer Pytheas of Massilia about 300 B.C. and was situated somewhere in the sea beyond northwestern Europe. Pytheas is supposed to have reached it after sailing six days from Britain; hence it has been variously conjectured to be one of the Shetland or Orkney Islands, the coast of Norway, or Iceland. The Romans sometimes referred to the land as "ultima Thule" (farthest Thule), and it thus became symbolic of any faraway, mysterious region. Pytheas reported that although the land was inhabited, it was bleak and its vegetation was sparse.

Thule is also the name of a small trading post established by the Danes on the northwest coast of Greenland in 1910, and the name is used by anthropologists to describe a form of Eskimo culture. G. Q.

**THULIUM.** *See* RARE EARTHS.

**THUMB, ALBERT** [tu'mb] (1865-1915), German linguist, was born at Freiburg in Breisgau on May 18, 1865. He taught from 1891 in Freiburg, later in Marburg, and from 1909 onward in Strassburg (Strasbourg). He died in Strassburg on Aug. 14, 1915.

Albert Thumb was perhaps the greatest of all specialists in Hellenistic, Medieval, and Modern Greek linguistic studies, and his works in these fields are still fundamental. He traveled in Greece and studied the Greek dialects, especially those of Amorgòs and Aegina, in their own areas. His masterpiece is *Die griechische Sprache im Zeitalter des Hellenismus, Beiträge zur Geschichte und Beurteilung der* Κοινή (1901). His *Handbuch der griechischen Dialekte* (1909, revised and enlarged by E. Kieckers in 1932) is highly condensed, but clear, useful, and very modern in its outlook, being based mainly on the application of geographical principles to linguistics. Other important works by Thumb include *Handbuch der neugriechischen Volkssprache* (1895), *Handbuch des Sanskrit* (1905), and *Grammatik der neugriechischen Volkssprache* (1915). He also wrote excellent linguistic works of a popular character and edited the fourth edition (1913) of K. Brugmann's *Griechische Grammatik.* G. B.

**THUN** [tu'n], a town in central Switzerland, in the canton of Bern, located on the Aare River 1 mi. below its efflence from the Lake of Thun and 16 mi. southeast of Bern, at an altitude of 1,854 ft. The town was founded in the twelfth century. In 1323 the castle and the town were sold to Bern. The older part of the town lies on the eastern bank of the Aare and centers around the twelfth-century castle of Zähringen-Kiburg which contains a historical museum with collections of old weapons and tapestries. The Rathaus built in 1589 was rebuilt in 1685. Near Thun lies the Alpine resort of Goldiwil, at an altitude of 3,280 ft. Many tourists use Thun as a gateway to the Alps, coming by train from Bern and continuing by boat from Thun to Interlaken. The climate of the town is between a mild Mediterranean climate and a bracing eastern inland climate. The July mean temperature is 64.5° F. A railroad center, Thun is noted for its art pottery and silver filigree. Other industrial products are cheese and metals. Pop. 1953, 25,200.

**THUN, LAKE OF** [tu'n], a lake of central Switzerland formed by a widening of the Aare River. Located southeast of Bern, it lies on the north side of the Bernese Alps at an elevation of 1,840 ft. The lake, 11½ mi. long and 2 mi. wide, has an area of 18 sq. mi. Its maximum depth is 702 ft. Along its shores are numerous resorts, such as Spiez, on the south shore (and on the railroad to the Lötschberg Tunnel), and Gunten, nearly opposite on the north bank. The north-shore towns face the high mountains of the Bernese Alps, a view for which the Lake of Thun is most celebrated. Lake steamers connect the town of Thun with Interlaken, which lies between the Lake of Thun to the west and the Lake of Brienz to the east. S. Van V.

**THUNDERSTORM.** *See* METEOROLOGY.

**THURBER, JAMES GROVER** (1894- ), American artist and author, was born in Columbus, Ohio, Dec. 8, 1894. He attended Ohio State University from 1913 to 1918. Tall, thin, and blind in one eye from a childhood accident, he suffered through the athletic and military program of the university in the World War I period. He once said that he fell down a good deal "because of a trick he had of walking into himself." He has drawn upon his life in Columbus for some of his best-known pieces.

Though barred from military service, Thurber had a phenomenal memory for names and details which made him valuable to the State Department as a code clerk in Washington and Paris (1918-1920). Afterward he returned to Columbus to write for the *Dispatch;* his special Sunday feature was a portent of things to come. In 1924 he joined the growing colony of Americans in Paris, working for the *Chicago Tribune* and developing his writing. Success was slow. He returned to New York and a job on the *Evening Post,* and began writing sketches which won him a place on the *New Yorker* in 1926. Thurber developed along with the magazine, but remained unique in his wry, allusive, psychoanalytical humor. His essays and drawings became books. With E. B. White, an early colleague on the magazine, he wrote a timely satire, *Is Sex Necessary?* (1929). It was followed in rapid succession by a series of books, each of which added to his growing fame: *The Owl in the Attic* (1931), *The Seal in the Bedroom* (1932), *My Life and Hard Times* (1933), *The Middle-aged Man on the Flying Trapeze* (1935), *Let Your Mind Alone* (1937), *The Last Flower* (1939), *Fables for Our Time* and *Famous Poems Illustrated* (1940), *The Male Animal* (with Elliott Nugent; 1940), *My World—And Welcome to It* (1942), *Many Moons* (1943), *Thurber's Men, Women and Dogs* (1943), *The Great Quillow* (1944), *The White Deer* (1945), and *The Thurber Carnival* (1945). H. Hr.

**THURGAU** [tu'rgau], a Swiss canton with an area of 388 sq. mi., southwest of Lake Constance, including most of the eastern part of the Swiss plateau, as well as most of the south shore of the lake. Thurgau is chiefly a rural section of crop fields and pastures, with a few large settlements. Frauenfeld is the capital and Romanshorn the chief lake port. Thurgau joined the Swiss Federation in 1803, after having been subject territory since 1460. Thurgau is bounded by Lake Constance and the Rhine River on the north, by Lake

Constance on the east, by the canton of St. Gallen on the south, and by the canton of Zürich on the west. Pop. 1953, 154,300. S. Van V.

**THURIBLE** [thyu′rıbəl] (Lat. *thuribulum,* censer), a container used by pagans, Jews, and Christians for burning incense. Anciently a vase with a perforated top, it was eventually equipped with four chains, one for raising the top, the others to enable the user to swing the thurible towards the person or object being incensed. In the West it is swung gently, one hand catching up the chains; in the East it is swung freely from the extremity of the chains. N. J. T.

**THÜRINGERWALD** or **THURINGIAN FOREST** [tü′rıŋərvɑ′lt, thyurı′njiən], a mountain system in Central Germany, extending from the neighborhood of Eisenach in the northwest to the Frankenwald in the southeast. The southern slopes reach down to the Werra River and the northern slopes descend toward the rivers Saale and Unstrut. The Saalfeld-Lichtenfels railway-line represents its eastern boundary. The Thüringerwald is about 70 mi. long by 6 to 22 mi. wide and averages 2,000 ft. in elevation, with peaks reaching to 3,240 ft. in the Beerberg and 3,022 in the Inselberg. Slopes of the block, descending steeply to the plains, are thoroughly dissected by deep stream valleys, the most beautiful of which is the Schwarza. The chain has a porphyritic backbone, with sandstone, granite, and porphyry predominating on the northwest and clay-slates in the southeast. The climate is mild and even. About 75 per cent of the area is forested, since poor soil and steep slopes render clearing unprofitable, although some meadow tracts exist. Most of the arable land is located in the valleys where the population engages in farming. Goat-raising and cattle-raising are carried on extensively, although the rather dense population has to rely primarily upon its highly developed industries, of which the most important are the toy industry and the manufacture of optical and precision instruments. With the exception of iron ore, lignite, and slate, the natural resources of the region are almost exhausted. C. C. H.

**THURINGIA (THÜRINGEN)** [thyurı′njiə, tü′rıŋən], a former state (*Land*), 6,020.82 sq. mi. in area, situated in central Germany and bounded by the *Länder* of Saxony-Anhalt on the north, Saxony on the east, Bavaria on the south, and Hesse on the west. It included the Thüringerwald, the northern part of the Rhön mountains, and the Saale River Valley. In the fifth century the Thuringians formed a large tribal state, which became tributary to the Huns and, conquered later by the Franks, was under Frankish rule from 634 to 804, when Charlemagne created the Thuringian Mark. In 1247, following the death of the Landgrave Henry Raspe, a war of succession broke out, which ended in 1263, when Henry of Meissen, of the house of Wettin, was awarded Thuringia. In 1485 it passed to Ernest, Elector of Saxony, and his descendants, by whom it was eventually divided into four duchies of Saxe-Altenburg, Saxe-Coburg-Gotha, Saxe-Meiningen, and Saxe-Weimar-Eisenach, and the principalities of Reuss and Schwarzburg. Under the Weimar Republic (1919-1933) the Saxe states were combined (with such modifications as the transfer of Coburg to Bavaria and the addition of several minor principalities) to form the *Land* of Thuringia. After World War II this state, which had a 1946 population of 2,927,497, was included in the Soviet occupation zone and, with other *Länder* of that zone, was dissolved in 1952.

About half of Thuringia is mountain forest and pasture land, and the rest is arable. The principal towns are Weimar (the former capital), Jena (a university and manufacturing town), Gera, Eisenach, Meiningen, and Gotha. Spas and health resorts include Friedrichroda, Ilmenau, and Oberhof. The Wartburg, the historic castle in which Martin Luther took refuge in 1521, is in the Thüringerwald south of Eisenach. The manufactured products of the area include optical glass, textiles, paper, leather goods, chemicals, scientific instruments, porcelain, musical instruments, Christmas-tree ornaments, and machinery. R. H. L.

**THURINGIANS,** a medieval tribe in Germany, very likely the descendants of the Hermunduri, a branch of the Suevi. The Thuringians first appeared in the fifth century A.D. as the allies of Attila. For a few decades in the latter part of the century, they controlled an area between the Elbe and the Rhine stretching southward from Saxony to the Danube. One of their kings married the niece of Theodoric, but this connection with the powerful Goths did not protect the kingdom from conquest by the Franks and Saxons about A.D. 531. T. B. J.

**THURNEYSEN, RUDOLF** [tu′rnaizən] (1857-1940), Swiss linguist and philologist, was born at Basel on Mar. 14, 1857. He studied Classical and Indo-European linguistics at Leipzig and taught at Jena, Freiburg in Breisgau, and Bonn.

Thurneysen began his career as a Latinist and continued throughout his life as a collaborator on the great *Thesaurus linguae latinae;* but he acquired his greatest renown in the field of Celtic studies, in which he soon became the leading figure. His *Handbuch des Altirischen* (1909) is far the best book on its subject and was translated into English and recast by Bergin in 1948. He also worked successfully on the Irish legends (*Die irische Helden- und Königssage bis zum XVII Jahrhundert,* 1921) and on Irish law (*Das keltische Recht,* in the miscellany *Studies in Early Irish Law,* 1936). He also published many articles, mainly of a linguistic character, in learned journals, and a number of works on Lycian, Lydian, and other ancient languages. Thurneysen died in Bonn, on Aug. 9, 1940. G. B.

**THURSDAY,** the fifth day of the week. It derives its name from the Middle English Thoresday, or Thursdaye, and it corresponds to the Roman *dies jovis.* Thor, the god of strength and thunder, defender and help in war, is the counterpart of Jupiter or Jove. The German counterpart to Thor is Donar, and the day is *Donnerstag.* Among Christians the Thursday preceding Easter is known as Holy Thursday, Big Thursday, Glory Thursday, Great Thursday, Green Thursday, Passion Thursday, and Maundy Thursday, and in general it commemorates Christ's washing the feet of his disciples. *See also* MAUNDY THURSDAY. A. L. H.-Q.

**THURSDAY ISLAND,** a low coral island in Torres Strait about 30 mi. off the northwest tip of Cape York Peninsula, Queensland, Australia. Its area is about 900 acres. The climate is hot and moist at all seasons due to the proximity of warm, tropical seas and the low latitude and altitude. There is a good harbor at Port Kennedy. The island prior to World War II was the base of operations for a fleet of small fishing boats that worked the reefs and shallow waters of Torres Strait, between Australia and New Guinea. Pearl shell, sea turtles, and *bêches-de-mer* or sea slugs made up most of the catch. The population, about 1,200 in 1935, was temporarily evacuated during World War II. The island belongs to Queensland. R. G. B.

**THURSTAN** or **TURSTIN** [thɜ′rstən, tɜ′rstɪn] (d. 1140), Archbishop of York, the son of Anger, or Auger, prebendary of St. Paul's, London, and the brother of Audoen, bishop of Evreux, was a native of Bayeux, Normandy, and a prebendary of St. Paul's. Thurstan was a clerk in the household of William Rufus, and became secretary to Henry I, who secured his election as archbishop of York in 1114. But Ralph d'Escures, Archbishop of Canterbury, refused to consecrate Thurstan unless he professed obedience to the see of Canterbury. Their dispute continued until 1119, when Thurstan was consecrated at Reims by Pope Calixtus II and as a consequence was forbidden by Henry to set foot in England. Three years later, however, he returned to England and was reinvested with the archbishopric, as a result of having rendered Henry useful services in Normandy. In 1137 he prevailed on David I of Scotland, who was preparing to invade England, to agree to a truce, and the following year raised an army in Yorkshire which routed the Scots at the Battle of the Standard. Thurstan was the founder of a number of monasteries in the north of England, and early in 1140 he entered the Cluniac order at Pontefract, where he died on Feb. 6, 1140. C. W. D.

**THUTMOSE III** [thutmo′sə] (c. 1501-c. 1448 B.C.), Egyptian pharaoh of the Eighteenth Dynasty, a great military leader and capable administrator, considered by many to have been the ablest ruler of Egypt in antiquity. It is uncertain whether he was the son of Thutmose I or Thutmose II, but during the first eleven years of his reign, which began in 1491 B.C., he was little more than the consort of the great Queen Hatshepsut. The death of the queen (c. 1480 B.C.) was the signal for the revolt of tribes in southern Syria which were restless under Egyptian domination. These tribes were supported in their uprising by the king of Kadesh, whose territory lay farther north along the Orontes River. In 1479 B.C. Thutmose took the field against the Syrian rebels, defeated them at Armageddon (Megiddo), and re-established Egyptian control in southern Syria. In the succeeding years more than fifteen Syrian campaigns were undertaken, carrying Egyptian arms far to the north. The seizure of Phoenician cities gave Thutmose a base for operations against the king of Kadesh, and after Kadesh fell Thutmose moved eastward across the Euphrates, where he defeated the powerful Mitannians. Thus, in the reign of Thutmose, there was created an Egyptian empire which extended from the third cataract of the Nile in the south to the borders of Anatolia in the north; the eastern Mediterranean was an Egyptian lake, and the navy of Thutmose may even have entered the Aegean. In keeping with his wealth and power, Thutmose was active in repairing and building temples in Egypt, particularly at Karnak. The twin obelisks which he erected in the precinct of Ra at Heliopolis now stand on opposite sides of the Atlantic Ocean: one on the Thames Embankment in London, and the other in Central Park, New York City. T. B. J.

**THYESTES.** *See* ATREUS, HOUSE OF.

**THYME** [tai′m], common name given to *Thymus,* a genus of small shrubs in the mint family. These erect or creeping perennials have small flowers and entire leaves borne in loose terminal or axillary clusters, and give off a pungent, mintlike odor. They are most numerous in the Mediterranean region, although the 50 species comprising this genus are natives of temperate climates. They are the source of valuable medicinal oils, are used as seasoning, and are also grown for garden ornamentals. The species most often planted in rock gardens and used for edging borders is the wild or creeping thyme, *T. serpyllum.* It has oblong, short-stalked leaves, prostrate stems, and many branches; although a native of the Old World, it is widely naturalized in the United States. The chief source of thymol, a substance much used in medicine is the common thyme, *T. vulgaris.* This plant

THOMÉ—DR. LASCOFF

*The root, leaf, and flower of the thyme plant*

is native to southern Europe and is cultivated extensively there. The narrow, sessile leaves and dense clusters of purple flowers are borne on slender, whitish branches; the whole plant grows to a height of about 8 in. The leaves are used in seasoning, either green or dried. M. G. W.

**THYMUS** [thai′məs], a ductless organ, found in all vertebrates. In man, it is situated in the lower part of the neck and the superior mediastinum.

**Structure.** The thymus is of grayish-red color and consists of two adjoining longitudinal lobes, joined, but rarely fused together. The lobes are subdivided into many lobules, made up of cortex and medulla, and is innervated by branches of both the vagus and the sympathetic nerves. The size of the thymus varies considerably with age. It increases up to the time of puberty and then begins to undergo continuous involution. In the embryo, the thymus is epithelial in origin, but prior to birth it becomes lymphoid, and this lymphoid character of the gland increases with age. Embryologically, it is associated with the parathyroid glands.

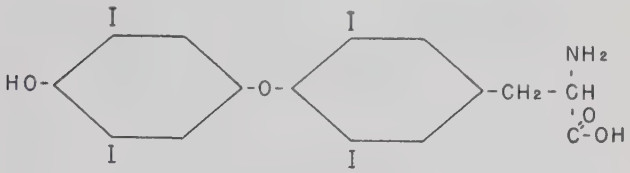
**Function.** The function of the thymus is still unknown. Probably, no organ is subject to so many contradictory hypotheses. Some authorities regard it as an endocrine gland, others as part of the lymphatic system, and still others as merely vestigial structure. The thymus is found in all vertebrates and its congenital absence is rare, but its presence, apparently, is not essential to life. Some authorities, however, attribute to the thymus an important part in growth, bone formation, and blood production. Doubts as to the endocrine nature of the thymus are contradicted by its interrelationship with the other glands of internal secretion, and since involution of the thymus usually begins at puberty it is possible that the gland is affected by the development of the reproductive organs.

*Disorders of the Thymus.* The thymus is subject to infection, inflammation, syphilis, and tuberculosis and is occasionally the site of tumors, chiefly malignant. Malnutrition and certain acute infections cause it to shrink and atrophy. On the other hand, it becomes considerably enlarged in Graves' disease, Addison's disease, acromegaly, rickets, and in about 20 per cent of cases of myasthenia gravis. The thymus becomes enlarged and fails to undergo involution in still another condition, known as status thymicolymphaticus. This condition is associated with hyperplasia of lymphatic tissues, a fat, flabby, overgrown body, adrenal atrophy, and underdeveloped heart and blood vessels. Victims are subject to attacks of cyanosis, coma, convulsions, and sudden death, known as *mors thymica.* Both the physiology and pathology of the thymus remain largely unsolved. *See also* ENDOCRINOLOGY.

B. Van R.

**THYRATRON.** *See* ELECTRONIC CIRCUITS (*Electronic Control*).

**THYROID GLAND** [thai′rɔid], a bilobed structure in the neck of mammals beneath the larynx. It arises as an outgrowth from the floor of the embryonic pharynx and consists of a series of small spheres of cells called




*THYROXINE*

follicles. The cavity of the follicle is normally filled with a storage form of thyroid secretion called thyroglobulin, an iodine-containing protein. Enlargements of the thyroid gland may be associated with either hypo- or hyperfunction and are called goiters. In 1916, Dr. E. C. Kendall, of Rochester, Minn., crystallized the iodine-containing hormone, thyroxine, for the first time. In 1926, Harrington, working in England, established the chemical nature of thyroxine and indicated that it was a derivative of the amino acid, tyrosine.

Traces of iodine are required in the diet for the production of thyroxine, and a high incidence of goiter is found in geographical regions where the iodine content of food is low. A new phase of thyroid study began in the 1940's with the discovery by the MacKenzies, of Baltimore, and Astwood, of Boston, that a series of drugs, of which thiourea and thiouracil are the most used, could block the production of thyroxine by the thyroid. Such drugs are frequently used in lieu of surgery to treat hyperthyroidism.

The function of the thyroid hormone is to stimulate oxidative processes in the body, i.e., the basal metabolic rate. When the hormone is absent, all metabolic activities are retarded; when it is present in excess, they are accelerated. *See also* GOITER.

R. G.

**THYRSIS** [thɜ′rsɪs], a poem published in 1866 by Matthew Arnold, commemorating his friend Arthur Hugh Clough who died in Italy in 1861. It is a pastoral elegy, Clough and Arnold figuring as the shepherds Thyrsis and Corydon. The spirit that Arnold recognized in Clough and in the Oxford countryside is presented as an indication of the persistent attractiveness of the idea of truth and of the desirability of striving toward it.

W. D. T.

**TIANG** [tyæ′ŋ], a medium-sized antelope, *Damaliscus korrigum,* of the upper Nile region of Africa. It is very similar to the topi of East Africa. A relative of the hartebeests, it has high shoulders and a long, slender head. The general color is cinnamon, except for the face, the front of the legs, and the bushy tail-tip, all of which are black. Both males and females have ringed horns about 20 in. long. *See also* ANTELOPE; HARTEBEEST.

V. H. C.

**TIARA** [tiɑ′ra; tɑiɛ′ərə] (Latin, from Greek *τιάρα,* an ancient Persian headdress), in ecclesiastical usage the pope's triple crown, a tall headpiece, somewhat ovate in shape, topped by a small cross, encircled by three diadems, and having two pendants attached at the back. The tiara is an insigne of sovereignty; at liturgical functions the pope wears the episcopal miter.

In the development of the tiara three periods may be distinguished. (1) The *camelaucum* was worn from the seventh or eighth century, probably first by the popes of Greek or Syrian origin. (2) Certainly before the twelfth century a royal circlet was added, which became a spiked crown by the end of the thirteenth century. (3) A second circlet was added by Boniface VIII (d. 1303), possibly as symbolic of his views concerning the twofold (spiritual and temporal) power of the papacy. Mention of three crowns is made in 1316, but the earliest monumental representation is found in an effigy of Benedict XII (d. 1342). Why a third crown was added is not known, though interpretations of the alternative name "triregnum" (Latin, triple rule) have been invented, e.g., authority over heaven, earth, and hell.

N. J. T.

**TIBBETT, LAWRENCE MERVIL** [tɪ′bət] (1896– ), American baritone, was born in Bakersfield, Calif., Nov. 16, 1896. From acting in Southern California stock companies he advanced to light opera and thence, after studying voice in New York with Frank La Forge, to the Metropolitan Opera Company, where he made his debut in 1923. After singing secondary roles for two seasons, he began a series of triumphs in important roles, including those in such American operas as Deems Taylor's *The King's Henchmen* (1927) and *Peter Ibbetson* (1931), Louis Gruenberg's *The Emperor Jones* (1933), and Howard Hanson's *Merry Mount* (1935). He has sung in recital tours throughout America and Europe, in radio, and in motion pictures.

W. Li.

**TIBER** or **TEVERE** [tai′bər, te′vere], second longest river in Italy, draining Latium, Umbria, and parts of Tuscany, and flowing into the Tyrrhenian Sea 20 mi. southwest of Rome. Its total length is 247 mi., and it drains an area of 6,700 sq. mi. The principal tributaries of the Tiber are the Topino, the Nera (with the Velino), and the Aniene (the ancient Anio) from the east, and the Nestore, the Chiana, and the Nepi from the west. The sources of the Tiber are in the Apennines on the border between Tuscany and Romagna, north of San Sepolcro. Its course is meandering, passing Città di Castello, Perugia, Todi, and Rome, and it enters the sea through two branches, the Fiumara near Ostia, which is the natural mouth, and to its right the artificial Fiumicino canal.

A safe anchorage at the mouth of the river was not afforded until the harbor of Ostia was built in the fourth century B.C. Later the Emperor Claudius built a new harbor on the northern side of the delta, which Trajan connected with the main branch of the river by a channel. Claudius, in an effort to stem the disastrous periodical floods of the Tiber, also built two large ditches near the mouth of the

river, one of which was enlarged by Trajan to form the Fiumicino canal. With the downfall of the Roman Empire, traffic on the Tiber declined and the port of Ostia filled with sand. At the end of the seventeenth century the river harbors of Ripagrande and Ripetta were built. In the nineteenth century, after an extremely severe flood, the government constructed walls along that part of the Tiber which flows through Rome. Other works, completed in 1948, include straightening the course of the river below Rome, installing new sewers, and reinforcing the earthen banks from Rome to the mouth of the river. At the present time, the Tiber is navigable by small craft during certain seasons to the confluence of the Nera, 40 mi. north of Rome, and a modern harbor is in operation on the southern outskirts of Rome. The Tiber and its tributaries, notably the Nera and the Aniene, are utilized for the production of hydroelectric power. Especially important is the group of hydroelectric plants at the foot of the Marmore waterfalls near Terni.

R. G. W.

**TIBERIAS** [taibi'əriəs], (*Heb.* Tveriah), a city in Israel, situated in a depression about 700 ft. below sea level on the western shore of the Sea of Galilee, also known as Lake Tiberias. Named after the Roman emperor Tiberius, the city was one of the Four Holy Cities of Palestine and an important center of Jewish learning from the Talmudic period to the Crusades. After a period of decline it regained its position briefly during the second half of the sixteenth century, but it was not until after 1948 that an accelerated development in its economic life made Tiberias one of the most flourishing centers in Galilee. In 1954 the population increased from 5,000 to 17,000, largely drawn by the mild climate and the thermal baths which have made the city famous since ancient times. New industries have been established, including machine shops, sausage, candy, and box factories; fisheries are operated on the Sea of Galilee.

Z. Y. H.

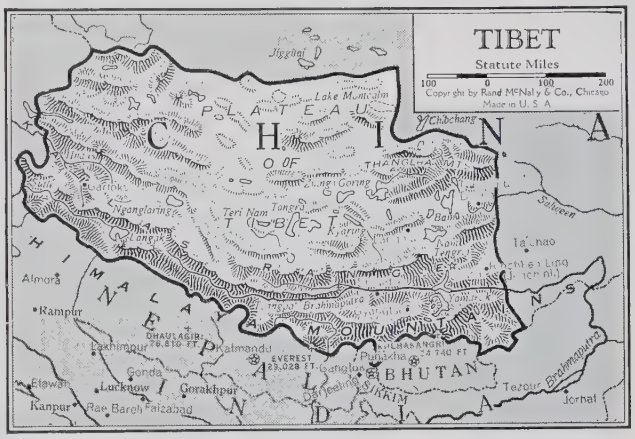
**TIBERIUS (TIBERIUS CLAUDIUS NERO CAESAR)** [taibi'əriəs] (42 B.C.-A.D. 37), Roman emperor, was born in Rome, Nov. 16, 42 B.C. Tiberius was the son of Livia Drusilla and Tiberius Claudius and the stepson of Augustus. After the death of Agrippa in 12 B.C., Tiberius and his brother Drusus became the principal generals of Augustus. When Drusus died in 9 B.C., Tiberius became the principal support of the aging emperor. He was subsequently adopted by Augustus and received the imperium and tribunitian power. Following the death of Augustus in A.D. 14, Tiberius was confirmed as emperor by the Senate and began a reign remarkable for its contradictions. On the one hand, he had many constructive laws passed, took care that his governors did not impose excessive taxation on the provinces, and lightened the financial burden of Rome itself by practicing a rigid economy. On the other hand, the historian Tacitus described him as a man of ruthless tyranny and cruelty. After the death of the two young men who might possibly have been his heirs—his nephew Germanicus (died A.D. 19) and his son Drusus (died A.D. 23)—Tiberius relied heavily upon the praetorian prefect, Sejanus, who was largely responsible for affairs in Rome when Tiberius withdrew to Campania, and later to Capri. Sejanus engaged in treasonable activities and in A.D. 31 he was executed at Tiberius' command. Tiberius died at Misenum, Mar. 31, A.D. 37, and was succeeded by his grandnephew, Gaius (Caligula).

T. B. J.

**TIBET,** a region of central Asia, which during most of its history has been a self-governing part of China. Under the Sino-Tibetan treaty signed at Peking on May 23, 1951, Tibet became virtually a province of Communist China. In 1928, the two new Chinese provinces of Tsinghai and Sikang had been set up, including both Chinese territory and what is usually termed "Nearer Tibet." "Farther Tibet," or Tibet proper, is approximately 350,000 sq. mi. in size. Tibet is bounded by the Chinese provinces of Sinkiang on the north, Tsinghai on the northeast, and Sikang on the east, by Bhutan, Nepal, and India on the south, and on the west by India and Kashmir.

## GEOGRAPHICAL FEATURES

**Topography.** Tibet consists of a high plateau with an average altitude of about 16,000 ft.; the valleys are no lower than 12,000 ft., and mountain ranges and snow-capped peaks, the highest in the world, extend above 28,000 ft. The country




may be divided into three major physiographic regions: Chang Tang, Southern Tibet, and Eastern Tibet.

Chang Tang, the northernmost region, lies just south of the Kunlun Mountains, which form its northern border. This chain has fairly continuous peaks which rise to heights of more than 23,000 ft.

The second of the major physical regions of the country is Southern Tibet, consisting essentially of the deep valleys of the upper Brahmaputra (known as the Tsangpo in this area), Sutlej, and Indus rivers. These river valleys, which lie at a general elevation of approximately 12,000 ft., are the most heavily populated districts of Tibet. Southern Tibet is bordered on the south by the Himalaya Mountains. On the west Tibet is approached by the Karakoram Range, a vast dissected highland.

The third of the broad physical regions of the country is Eastern Tibet, which is an area between the Chang Tang and the Chinese provinces of Tsinghai and Sikang. This is a region of deep valleys separated by high ranges, and it is here that the great rivers, such as the Hwang Ho (Yellow River), Yangtze, Mekong, and Salween, originate and flow eastward and southeastward into China and the Peninsula of Further India.

**Mineral Resources.** Tibet is not an important source of mineral raw materials. Its resources are reputed to be rich, but they have never been carefully surveyed, and the output of those products is of minor importance. The more important minerals produced in Tibet are borax, gold, and salt, but only borax has been exported in significant amounts to the outside world, principally to India. Borax, soda, and salt are found mainly in the salt lake region of Chang Tang. Gold is reported to be widely distributed throughout Tibet, but only small amounts are mined.

**Climate.** The climate of Tibet is largely controlled by its deep interior position on the continent of Asia, by the encircling mountain ranges, which prevent the access of moisture-bearing winds, and by the generally high elevation, with correspondingly low temperatures. Although all parts of the region are more or less affected by these forces, the climate is far from uniform and varies from the mild and even subtropical conditions in Southern Tibet, to the cold steppe and desert climate of Chang Tang and the semipolar conditions of the northern and northwestern mountains. The region experiences extremely severe winters, in which the cold is intensified by strong, biting winds, and during this time most of the mountain passes are impassable. Winter temperatures are known to drop as low as −40° F. On the other hand, summers are relatively warm, especially in Southern Tibet, where average July temperatures of 68° F. or more have been recorded. Perhaps the most uniform climatic characteristic of Tibet is its generally scanty precipitation, which is estimated to average about 8 in. of snow and rain a year, but here again there are variations within the country. This precipitation, which comes mainly during the summer, generally declines from the south to the north with increasing distance from the sea, and the intervening mountain ranges capture most of the rainfall before it reaches the Chang Tang, Karakoram, and Kunlun.

**Flora.** The vegetation of the greater part of Tibet is extremely sparse and is characteristic of alpine and desert regions. The plains and mountains of northern and northwestern Tibet usually have a short grass cover, with some isolated bushes and stunted trees in the more sheltered and wetter areas. In southern and southeastern Tibet, on the other hand, especially in the region just north of the Himalayas, the plant cover is more profuse and subtropical in character because of the greater rainfall and greater warmth. Here woodland is more common, and the forests include such deciduous trees as birch, poplar, maple, walnut, and oak and several varieties of conifers.

**Fauna.** Many varieties of both wild and domesticated animals are found in Tibet. The wild breeds are most abundant in the mountains, but they are also common to the open steppes. They are usually well adapted to the extremely low winter temperatures of the region. Some of the common types of animals found in Tibet are the yak, antelope, wild sheep, wild goat, wild ass, marsh deer, bear, wolf, fox, and several varieties of ducks and pheasants. A. L. R.

## ETHNOLOGY

**Racial Origins.** The peoples of Tibet originated from all the surrounding areas, and they show a marked variation in physical type. The predominant Tibetan type is short and stocky and has strong Mongoloid features, with flat nose, thick lips, high cheekbones, light brown skin, coarse dark hair, and very little beard. The second type of Tibetan is more closely akin to the Karens of Burma and is tall, broadfaced, and large of frame.

**Language.** The Tibetan language, which is monosyllabic, belongs to the Sino-Tibetan group of languages.

*SPECTATORS VIEWING THE TENGECHOLING DANCE IN MOUNTAINOUS TIBET*

E. W. FLETCHER FROM BLACK STAR

**Religion.** The people of Tibet are followers of Lamaism, which is a modified form of Buddhism compounded with primitive magic and animism. More than one third of the population are monks, who, after a period of study and training, may qualify to become lamas (Superior Ones).

**Population.** The population of Tibet is estimated to be about 1,500,000. The capital city of Lhasa has an estimated population of 25,000. Long closed to foreign visitors, Lhasa has been known as the Forbidden City because of its religious secretiveness and animosity to outsiders. The second largest city, Shigatse, which has an estimated population of 9,000, lies on a western caravan route, and carries on an extensive trade. The third largest city, Gyangtse, has an estimated population of 5,000; it is a junction point for caravan routes and is noted for its manufacture of carpets.

## GOVERNMENT AND ECONOMIC CONDITIONS

**Government.** The Dalai Lama, the head of the Lamaist religion, formerly governed Tibet as an absolute ruler. In

the Sino-Tibetan treaty of May 1951 the Chinese Communists guaranteed that his "established status, functions, and powers" would not be altered. However, within three months after the treaty was signed, all local officials in Tibet had either been replaced or were working for the Chinese Communists. All Tibetan armed forces had been incorporated into the Chinese Communist Army. The Chinese Communists proceeded to build airfields in Tibet and established an extensive road-net and radio communication system to facilitate their control over the country.

**Trade.** Tibet's external trade is confined chiefly to China and India. The chief commodities exported to China are wool, rugs, musk, gold, salt, rhubarb, deerhorns, amber, borax, yak hides, foxskins, and sheepskins. In return China sends tea, cotton goods, rice, porcelain, cereals, and silk. The trade with India is, for the most part, an exchange of Tibetan wool and salt for the manufactured goods of Bombay and Calcutta. When the Chinese Communists took control of Tibet, they introduced their own currency and attempted to control all trade, particularly that in raw materials. This has caused alarm in India, which fears the diversion to China of wool formerly purchased from Tibet.

## HISTORY

Little is known of the history of Tibet prior to the seventh century of the Christian Era, although it is known that Buddhism was introduced during this time. The period between the seventh and fourteenth centuries was one of kingly rule, from which Buddhism and priestly power, after some recession, finally emerged with renewed strength and influence. The rule of the Dalai Lamas or "priest kings" began in the thirteenth century, and the system of priestly incarnation was begun in the latter part of the fifteenth century, under the rule of the Second Dalai Lama. This system is founded on the belief that the spirit of a departed lama is incarnated in some living person, who thereby becomes his successor.

The Tibetans regard the Fifth Dalai Lama, who reigned during the seventeenth century, as their greatest monarch. It was during his reign that the great Potala Palace, which still stands in Lhasa as the emblem of priestly sovereignty, was constructed. It was during this time also that the first European, purported to have been a Portuguese, visited Tibet. In the early years of the eighteenth century the Chinese established representatives in Lhasa who took an active part in the administration of Tibetan affairs. Later in that century Warren Hastings, an Englishman, established friendly contact with the Regent of Tibet, but it came to nothing, since the Tibetans believed that the British had aided and abetted an invasion of Tibet by Nepal in 1792.

One of the significant facts in the history of Tibet has been its exclusiveness and isolation, which reached their peak in the nineteenth century, when the country was completely closed to Europeans. Tibetan history in the early years of the twentieth century was characterized by a triangular struggle for power between the British, the Chinese, and the lamas. In 1904 a British Expedition led by Sir Francis E. Younghusband entered the Forbidden City and negotiated a convention which provided for trade and forbade Tibetans to grant concessions without British consent. In 1906 China confirmed this agreement, at the same time establishing safeguards against further aggression by the British.

An Anglo-Russian agreement of 1907 recognized China's suzerainty in Tibet, and in an attempt to strengthen its position in the country China then embarked upon a policy of force. This created resentment among the Tibetans, and in

COURTESY OF LOWELL THOMAS

*THE FOURTEENTH DALAI LAMA*

1912 they drove the Chinese from their country and in 1913 declared their independence. During the ensuing two decades British influence was greatly expanded in Tibet.

After 1932 the Chinese were again permitted to send representatives to Lhasa, and during the war years in China, from 1937 to 1945, the two countries were drawn into a new and closer unity. At the same time, Tibet began to relax its policy of isolation to some degree, and in 1947-1948 a Tibetan trade commission visited India, China, Great Britain, and the United States. By 1950, however, Tibet was under strong political and military pressure from Communist China and has since been occupied and virtually absorbed into that country. Considerable apprehension has been aroused in India by the presence of Chinese forces in Tibet. The Chinese Communists also apparently plan to infiltrate and subvert the small states lying between India and Tibet as well as the border areas in Indian territory inhabited by peoples never completely controlled by the Indian Government. Some special measures are being taken against these dangers, but the threat does not yet seem to have caused any deterioration of relations between India and Communist China.

G. G. C. and D. N. R.

**TIBETAN** [tɪbɛ′tən], an important member of the Tibeto-Burman group of the Sino-Tibetan languages. It is spoken chiefly in Tibet and in parts of the western Chinese provinces of Sikang, Tsinghai (Koko Nor), and Kansu and has about two million speakers. It has a large number of dialects, most of which have not yet been studied scientifically, but the generally recognized standard form of speech is the dialect of Lhasa.

The Tibetans derived their script, in the seventh century of the Christian Era, from the *devanagari* alphabet of the Hindus. There are now two varieties of this script in common use, the regular or printed type and the cursive type. It is generally believed that the earliest record consists of an

inscription of the ninth century, although some manuscript fragments have been claimed to be earlier. There is a large body of literature extant, which consists chiefly of translations of Buddhist sutras and their commentaries.

The modern colloquial Tibetan differs greatly from the written language, generally called classical Tibetan, in which the Buddhist literature is written. Classical Tibetan has a large number of consonantal prefixes which, though kept in some dialects, are dropped in the modern Lhasa speech; initial consonant clusters, like *pr-, br-, kr-, gr-, pl-, bl-,* and others, are simplified, and final consonants, like *-d* and *-s,* are dropped, though still kept in the script. Different tones are developed depending upon whether or not the syllable possesses a prefix and whether the syllable begins with a voiced or a voiceless consonant. The use of prefixes and of vocalic and consonantal changes, largely obliterated in the modern speech, is best illustrated in the formation of verbal aspects and derivatives in classical Tibetan. For example, in the word for "fill" *ḥgeṅs-pa* is the imperfect, *bkaṅ* the perfect, *dgaṅ* the future, and *k'oṅ* the imperative; *sgaṅ-ba* is "to grow or become full" and *skoṅ-ba* "to fulfill."

F.-K. L.

**TIBETO-BURMESE.** *See* Asiatic Tribes (*Sinitic*).
**TIBETO-CHINESE.** *See* Sino-Tibetan.
**TIBU.** *See* African Peoples.

**TIBULLUS, ALBIUS** [tɪbʌ'ləs] (c.54-c.19 B.C.), Roman elegiac poet, was born about 54 B.C. near Pedum, in Latium, of a family of the lesser nobility. Our scanty knowledge of his life is derived from the first two books of elegies bearing his name, from casual mention by other ancient authors, and from an unreliable vita contained in the manuscripts of his work. His property was apparently confiscated in 41 B.C., but it was later restored to him, presumably because of his friendship with Marcus Valerius Messala Corvinus, a prominent statesman and soldier, but also a poet, orator, and patron of letters and the center of a literary circle. Tibullus was a friend of Horace and Ovid; he also seems to have accompanied Messala on a campaign in Gaul, and would have journeyed with him to the east, except that he was detained by illness at Corcyra.

Tibullus' journeys with Messala involved separation from Delia, the consuming passion of his life and the subject of the ten elegies of his first book. Of Delia, whose real name appears to have been Plania, Tibullus gives us no chronological or consistent account. At times she appears as single, but again, as when Tibullus' intimacy with her seems to have been aided by her husband's absence in Cilicia, she is presented as married. Tibullus alludes also to rivals for Delia's affections, but his patience sufficed to keep him from taunts and reproaches. The six elegies of Book II are addressed to Nemesis, apparently a high-class courtesan, and it appears that despite vexation at his own bondage and consciousness of his mistress' greed and selfishness, Tibullus loved her till his death. To manuscripts of Tibullus is appended a third book of six inferior elegies addressed to Neaera by a certain Lygdamus, seemingly also a member of Messala's circle. A fourth book, of yet different authorship, which in some manuscripts is treated as a continuation of Book III, contains a tasteless panegyric of Messala in 211 hexameters, and also five elegies in which Sulpicia, Messala's niece, unblushingly yet charmingly confesses her love for the youth Cerinthus.

Tibullus' imagination is neither powerful nor wide-ranging, but although his thoughts as a lover are conventional they seem none the less sincere. His mood is pensive, and his verse is musical and charming. G. McL. H.

**TICINO** [titshi'no], a small Swiss canton, 1,086 sq. mi. in area. Ticino is the only Swiss-Italian canton. It joined the Swiss federation officially in 1803, after having been subject territory since the beginning of the sixteenth century. Bellinzona is the capital. The chief resort towns are Locarno and Lugano. The concentration of population is in the mountain valleys which lead from the Swiss-Italian lakes to the Lepontine Alps. Pop. 1953, 178,600. S. Van V.

**TICINO,** a river 155 mi. long which rises in Switzerland, in the Lepontine Alps southwest of St. Gotthard Pass, at 9,500 ft., and flows into northern Italy. The largest tributary of the Po, the Ticino in its upper course describes a large curve, following the Valle Leventina, where it is joined by the Brenno and Moësa rivers. This section of the Ticino's valley is followed by the St. Gotthard railway and has always represented a most important communicating link between the Po Valley and the countries of Central Europe. The Ticino then enters Lake Maggiore at its northern end near Locarno and comes out of it at its southern end at Sesto Calende. From this point on, the Ticino marks the historical border between Piedmont and Lombardy, continuing its course to the southeast. A large amount of its water is diverted for irrigation purposes. The Ticino empties into the Po River, 3.5 mi. downstream from Pavia. L. J. W.

**TICKBIRD,** a name applied to any one of several birds, such as the oxpecker, which alight on the backs of cattle to feed upon the vermin with which the animals are infested. However, the tickbird is better restricted to three species of tropical New World cuckoos united in the genus *Crotophaga.* They are characterized by high, compressed, arched bills, and their feathers are black, with bluish reflections. All are gregarious, even in breeding season, when each flock builds a communal nest in which the females lay their eggs and share the duties of incubation. Tickbirds are known also as anis.

H. G. De.

**TICKELL, THOMAS** [tɪ'kəl] (1686-1740), English poet, was born Dec. 17, 1686, at Bridekirk, Cumberland. He attended Queen's College, Oxford, taking a bachelor's degree in 1705 and a master's in 1709. Through his interest in poetry he was introduced to the Whig sphere of Joseph Addison, whom he served as under-secretary in an Irish post from 1714 to 1717 and in the British cabinet from 1717 to 1719. Addison's praise of Tickell's translation of the first book of the *Iliad,* published two days after Alexander Pope's, was an element in the subsequent alienation of Pope and Addison. In 1721 Tickell edited Addison's works, adding an elegy which Dr. Johnson praised highly. He died at Bath, Apr. 21, 1740. H. Pe.

**TICK FEVER.** *See* Rickettsia.
**TICKING.** *See* Textile Fabrics (*Cotton Fabrics*).

**TICKNOR, GEORGE** [tɪ'knər; tɪ'knɔr] (1791-1871), American scholar and educator, was born Aug. 1, 1791, in Boston. After extensive travel and study abroad, he became in 1819 professor of modern languages at Harvard, where he introduced German pedagogical methods. He resigned in 1835 to devote himself to the writing of his *History of Spanish Literature* (1849), the fruit of assiduous research and study, and one of the most widely esteemed literary histories ever published in America. In this work Ticknor

investigated the origins of Spanish literature, traced its progress to the early years of the nineteenth century, and devoted an appendix to a discussion of the origin of the Spanish language. His literary output included further a number of biographical works, the most important of which is the *Life of William Hickling Prescott* (1864). Ticknor was also instrumental in founding the Boston Public Library in 1852. He died in Boston, Jan. 26, 1871. N. F. A.

**TICKS,** large mites which are parasitic on mammals, birds, and reptiles. They are the largest members of the order Acarina, and the ones which most frequently come to the attention of man; certain females when full of eggs and blood may reach 1 in. in length. They suck the blood of their hosts. The females usually remain attached until they are ready to lay their eggs, at which time they drop to the ground. The males are much smaller and commonly wait on the tops of low plants for some animal to come along, to which they readily transfer. Aside from the annoyance of their bites, ticks may also cause serious diseases as the result of carrying parasitic organisms in their bodies. Rocky Mountain spotted fever in man and Texas fever in cattle are among the better known and more serious of these diseases. *See also* Arachnida; Mites. W. I.

*FORT TICONDEROGA, ORIGINALLY CALLED FORT CARILLON, WAS BUILT AT THE HEAD OF LAKE CHAMPLAIN IN 1755 BY THE FRENCH.*

NYSPIX—COMMERCE

**TICONDEROGA** [tai′kɒndəro′gə], a village and fort in Essex Co., N. Y., about 85 mi. north of Albany, on the La Chute River on a neck of land between Lake George and Lake Champlain. The name is derived from the Iroquois Indian word meaning "between two waters." In 1755 the French built a military road along the Indian portage between the two lakes and constructed Fort Carillon, later named Fort Ticonderoga, some miles away on a bluff overlooking the village. From here Montcalm set out in 1757 to capture Fort William Henry at the head of Lake George. On July 4-8, 1758, an attempt to capture the fort by General James Abercrombie, with a force of 16,000 men, was beaten off by a garrison of less than 4,000 French; the first shots fired in this long and hard battle caused the death of Lord Howe. In 1759 the fort was captured by General Jeffrey Amherst, and it then became Fort Ticonderoga. At the beginning of the Revolutionary War the fort was captured by surprise on May 10, 1775, by Ethan Allen and his Green Mountain Boys. In 1777 the American garrison was forced to evacuate the fort by the superior forces of General Burgoyne's expedition. Prior to its surrender later in that year by the Convention of Saratoga, by which Burgoyne surrendered his troops to General Gates, Colonel John Brown made a daring but unsuccessful attempt to wrest the fort from the British. In 1780 the British retook the fort without a fight but abandoned it within a few months. The site of the fort was purchased by William Ferris Pell in 1820. In 1909 the crumbling fortifications were restored and a historical museum, visited yearly by thousands of tourists, was built near by.

The town is an important paper and lead-pencil manufacturing center. A 30-ft. waterfall in the river at the outlet of Lake George provides power for the pulp and paper mill and for the pencil factory. The pencil industry grew up around a graphite mine discovered in 1815; however, it is now cheaper to import the graphite than to work the local mines. The village was incorporated in 1889. Transportation is provided by the Delaware and Hudson Railroad. Pop. 1950, 3,517. C. W. D.

**TIDES,** the periodic rise and fall in the waters of the earth, produced by the gravitational attraction of moon and sun acting upon a rotating earth. All large bodies of water, including oceans, seas, and lakes, exhibit tides to greater or lesser degree, although in lakes the effect is small.

The greatest elevation of the waters on a given day or half-day is known as high tide, and the greatest depression

is termed low tide. The exact moment at which the absolute tidal peak or depression is reached, and at which no change in vertical height is observed, is the "stand" of the tide. Mean sea level is the resulting data when the sea level is measured with respect to an arbitrary mark (above which high tide rises and below which low tide falls), and when the average of a large number of such measurements spaced at equal intervals of time is taken. Mean tide level is the computed mean of an extensive series of measurements of the height of tide at high water and at low water. Both of these mean levels are referred to a local datum mark. Mean sea level and mean tide level are not synonymous, for usually the tide does not rise at the same rate it falls. The range refers to the difference, in feet and tenths of a foot, between high-water and low-water levels encountered at any one location.

The vertical rise and fall of tides is accompanied by a horizontal movement of approach and recession of the waters with respect to the seashore. By the adjustment in vertical height of the tides, as well as other causes (wind, outflow of streams, etc.), large-scale horizontal movements are induced in both coastal and offshore waters. These horizontal movements are clearly distinguished from tides by their designation as tidal currents. Tidal currents should not be confused with ocean currents, which are of other than tidal origin. All tidal phenomena are characterized by periodicity. Tidal currents are recurrent in time, and alternate in direction of flow, whereas ocean currents, continuous and progressive in movement, are caused by the general wind circulation of the atmosphere, and occupy a considerably larger portion of the open sea.

The period during which the prevailing horizontal movement of the tidal current is from sea toward land is described as flood; the opposite cycle, during which the current is running from land toward sea, is known as ebb. It is important to note that flood and ebb do not necessarily correspond with high tide and low tide, respectively. The exact time of change from ebb to flood, or reverse, when no tidal current is observed, is termed slack water. Slack water, likewise, need not be coincident in time with tidal stand. The set of the tidal current defines the direction of current movement; and drift indicates the velocity of the current.

Tides repeat themselves in an alternating cycle of "highs" and "lows" in accord with changing astronomical, hydrological, and meteorological circumstances. The periodic phase of high and low tides is caused by two tidal bulges and two tidal depressions, with modifications thereof.

**Explanation of the Tide-raising Force.** Although the sun plays a measurable role in tidal phenomena, the predominant factor responsible for the tides is the force of the moon's gravitational attraction. Each particle of water, wherever situated on the earth's surface, is influenced by tidal action to an extent determined by Newton's Law of Gravitation. This law states that every particle of matter in the universe attracts every other particle with a force that varies directly as the product of the two masses concerned, and inversely as the square of the distance between them. The law implies that the more massive two bodies are—that is, the greater the amount of substance each contains—the greater the force of attraction exerted between them will be. (For the same distribution of density, a small body exerts less gravitational attraction than a large one.) The law also asserts that the farther two bodies are apart, the less the gravitational force exerted between them. The effect of distance between the two bodies plays a much more important role in determining the magnitude of the tide-raising force than does the ratio of their masses.

The gravitational pull of the earth on the moon (tending to keep the latter in its orbit around the earth) is opposed by the pull of the moon on the earth—a force smaller in amount in proportion to the moon's smaller mass, but nevertheless tending to pull the earth toward the moon, and also tending to "lift" any objects on the earth's surface toward the moon.

A point on the earth's surface directly beneath the moon is only 4,000 mi. from the earth's center and, on the average, 234,850 mi. from the moon's center. Thus, at this point on the earth's surface, the pull of the earth on any object is nearly 9 million times stronger than the pull of the moon on the object. It must be emphasized, therefore, that the moon's direct pull is insufficient to lift the enormous weight of the waters of the earth by any amount whatsoever, and that, contrary to popular belief, the vertical component of the moon's gravitational attraction plays no part in the production of the tides. In short, the tides, despite a common misbelief frequently asserted, are not caused by a vertical uplift of the waters of the earth due to the lifting effect of the moon. Furthermore, the highest tides are not usually produced with the moon directly on the meridian of a given place.

The oceans, seas, and large lakes of the earth's surface (as fluid bodies) are, however, free to move under the action of a sideward displacing force, and any slight tendency toward horizontal movement will cause them to flow. All waters not directly underneath the moon are acted upon by a horizontal component of the moon's gravitational attraction as well as a vertical component, and undergo a horizontal movement relative to the earth's solid crust. The result is a flow of water from adjacent regions on the earth's surface toward a position underneath the moon. The resultant amassing of waters at a point beneath the moon produces a high tide at this position. The actual tidal bulge in the open ocean is only one or two feet in height, but this is augmented greatly when the tidal bulge is thrust up against continents, islands, etc. By the removal of water from adjacent regions toward the sublunar point, a corresponding low tide is produced at two other points, each a quarter of the way around the circumference of the earth. Paradoxically, the lowering of the ocean water at these two low-tide positions is accompanied by an accumulation of water not only on the side of the earth directly under the moon, but also on the side exactly opposite the moon. The explanation lies again in Newton's Law. Two objects at different distances from the same attracting force, and hence subject to different degrees of acceleration, undergo a relative displacement with respect to each other, as the closer object is urged more toward the center of attraction. The tidal bulge on the side of the earth directly beneath the moon is known as the direct tide; that in the antipodal position, the opposite tide. The direct tide is barely 5 per cent greater than the opposite tide.

Due to the movement of the moon in its orbit about the earth, two successive high tides or two successive low tides at a given location occur approximately 12 hr., 25 min. apart; the time between a high tide and the next succeeding low tide is about 6 hr., 12 min. The period of 24 hr., 50 min. between successive high tides is known as the tidal day.

**Tidal Inequalities.** The action of the tide is very complex, involving many factors which must be considered to describe exactly the tide at any place. At any station, the principal features are specified by (a) the time-relation of the tide to the moon's transit, (b) the range of tide, and

(c) the type of tide or form of tide-curve. The numerous variations in direction and intensity of the tide-raising forces cause differences in morning and afternoon tides at a certain port, and also differences between the same tides at separate ports. These differences are called tidal inequalities.

*Semi-diurnal Effect.* This is the principal tide-raising force, usually giving two complete cycles in a day, the cause of the period being the rotation of the earth. The moon revolves around the earth in the same direction as the earth rotates on its axis, counterclockwise looking down from the north ecliptic pole. It therefore requires a little extra time for a given point on the earth's surface to "catch up" to a position directly underneath the moon at each successive rotation. For this reason, both high tides and low tides occur, on the average, approximately 50 min. later each day. This quantity is termed the lunar retardation.

*Semi-monthly Inequality.* This is the principal variation and has a period of about 13 5/6 days, the cause being the moon's revolution around the earth, and the phase or alignment of the sun, moon, and earth. When the sun and moon are in line, either on the same side or on opposite sides of the earth—at new or full moon—and their gravitational forces pull together along a common axis, the high tides due to the sun are superimposed upon the high tides due to the moon; similarly the alignment of the sun's gravitational force detracts from the low tides due to the moon. The result is that the high tides are higher, and the low tides lower, than those produced by the moon alone. Tides showing such effects of reinforcement of gravitational action are called spring tides.

When the gravitational forces of sun and moon act along lines at right angles to each other—as at first-quarter and last-quarter moon—the tide-raising effects of sun and moon tend to cancel each other, since the high tide produced by the sun is superimposed upon the low tide caused by the moon. Under such conditions, the high tides are not as high, nor the low tides as low as produced by the moon alone, and these intermediate tides are known as neap tides. The range between high and low, in this case, is reduced by a factor of more than one half, as compared with spring tides. In the Atlantic Ocean, both spring and neap high tides usually follow the appropriate phase of the moon by a full day; in the Pacific, the delay is only five hours. At New York and San Francisco harbors, and in the Gulf of Mexico, spring tides are 40 per cent greater than neap tides. This effect is additive to other possible effects.

*Lunar Parallactic Inequality.* The period of this effect is 27⅓ days and the cause is the changing distance of the moon from the earth during its revolution. Because of the ellipticity of the moon's orbit, the tide-raising influence of the moon at perigee may be as much as 40 per cent greater than at apogee. This is for New York Harbor, where the effect of apogean or perigean tides is usually discernible about 1½ days after the appropriate lunar phase is reached. For San Francisco Harbor, the difference produced by perigean and apogean tides is only 32 per cent and follows the appropriate lunar phase by two days.

*Diurnal Inequalities.* The period of this effect is 24 hr. 50 min. The cause is the rotation of the earth and the varying declination of the moon. When the moon is near the celestial equator, the two high tides on a certain day (and also the two low tides) are not very different, and the morning and afternoon highs (or lows) are quite similar. But as the moon increases its northern or southern declination, the morning and afternoon tides of the same kind begin to differ, and when the moon is at maximum northern or southern declination the differences are extreme, resulting in tropic tides. These tides are so called because the moon is nearly above the earth's tropics of Cancer and Capricorn.

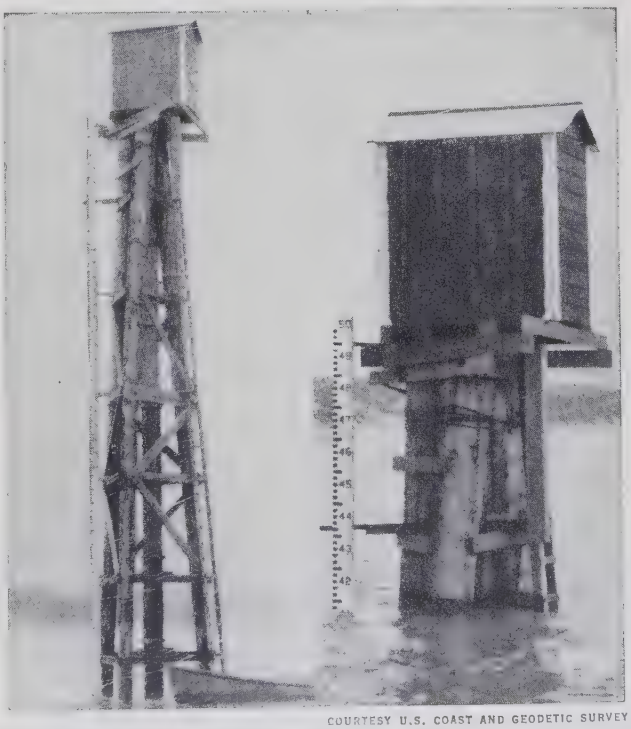
Diurnal inequality does not materially affect the heights of two successive low tides in the Atlantic and, even in high tides, the effect is small compared with the total range. However, in the Pacific, the diurnal inequality in the low tides is three times that occurring in the high tides.

*Semi-annual Inequality.* The period of this effect is one-half year, and the cause is the earth's revolution around sun and the sun's varying declination. Twice a year—for several days around equinox times—the sun is close to the celestial equator, its declination being nearly 0°; and for a day or so during every half-month, the moon is likewise nearly on the celestial equator. When the sun is at the equinoxes, therefore, there is an interval when the declinations of the moon and the sun are both nearly 0°. The combined gravitational effect of the two tide-raising bodies at such times most noticeably affects a station near the earth's equator. If at the same time the moon is at new or full phase, so-called equinoctial spring tides occur.

*Solar Parallactic Inequality.* The period of this effect is one year and the cause is the variation in distance of the earth from the sun during the earth's revolution. Once each revolution, the moon comes to its closest approach to the earth (perigee). Once each year, about January 2, the earth in its orbit also reaches its position of closest approach to the sun (perihelion). When these two times of closest approach coincide, giving the greatest combined attracting force, greater high tides and more exaggerated low tides may be expected. Similarly, if aphelion coincides with apogee, reduced high tides and less severe low tides are the result.

**Instruments and Tide Predictions.** Measurements of changing level of the tides are secured by means of tidal gauges, which may be of several kinds.

*Staff Gauge.* The staff gauge is a simple scale graduated to read in feet and tenths of feet, attached vertically to a pier

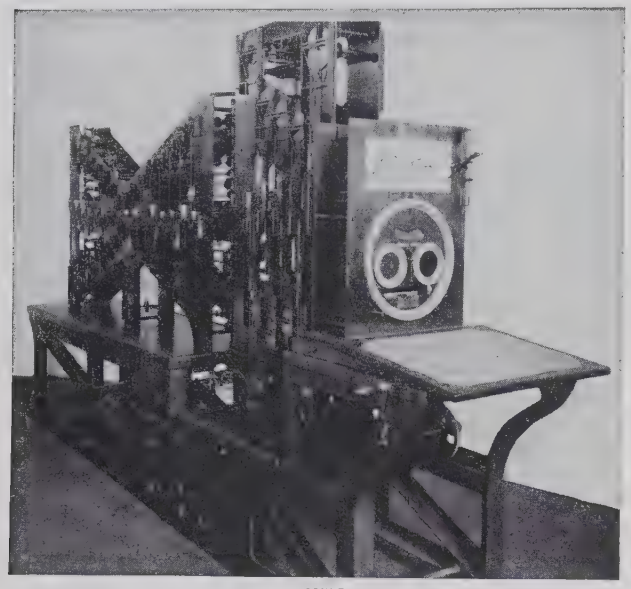


COURTESY U.S. COAST AND GEODETIC SURVEY

*Tide gauge, Anchorage, Alaska;* (left) *low tide;* (right) *high tide*

or fixed support in the water so that the zero-index lies below the lowest level of the tides. The changing height of the water surface is read directly from this fixed scale.

*Box Gauge.* The box gauge is used where continuous waves, ground swells, or choppy seas make readings of the staff gauge difficult. In this type of instrument, a floating gauge is enclosed within a protecting float-well, consisting of a hollow box or pipe anchored to the ocean floor, and to which the changing tides have access only through a tiny opening deep below the surface of the water. Readings of the tide-level are made from the index portion of the floating staff, rod, or tape, which protrudes from the float-well.



COURTESY OF U.S. COAST AND GEODETIC SURVEY

*TIDE-PREDICTING MACHINE*

*When set to certain predetermined constants, this machine automatically gives the times and heights of the tide of any port in the world and for any year.*

*Pressure Gauge.* In the pressure gauge, variations in the height of the tide above a group of rubber sacs located at a fixed depth in the water are indicated by a changing hydrostatic pressure as the water-level changes. The pressure readings are communicated from the sacs below the water to a pressure gauge at the surface. Automatic registering devices may also be used to provide a continuous record of tidal changes at any one station.

*Tide Tables.* The United States Coast and Geodetic Survey has 61 stations in operation within the continental limits of the United States and 23 stations in territorial waters for observation of the tides. Their annual *Tide Tables* contain tide predictions for 172 principal world ports and 4,900 supplementary ports; current tables of lesser scope and magnitude are also published.

In the prediction of the data for the tide tables, two principal methods are used, the non-harmonic and harmonic methods. The non-harmonic method is based entirely upon observations. In addition, this procedure makes use of the "establishment of the port" and certain basic astronomical data pertaining to the hour-angle of the moon, the time of its meridian passage, its phase, declination, and parallax. After the corrections have been applied for these various factors, the calculation of the time and height of the tide for any port is a mathematical procedure.

The harmonic method is partially analytical and partially by observation of the tides extending over at least one lunar month. Long observations are needed at each port for confirmation of such predictions because of the physical properties of inertia and friction, and the many complexities in the configuration of land masses and water basins. Since tides are periodic, the procedures of harmonic analysis may be applied in this method. The observed tide is assumed to be composed of a series of simple constituent tides, each produced by a different tide-raising force or component. Of these, thirty-seven are employed to complete the solutions, although in some cases the additional components beyond twenty are almost negligible. The simultaneous introduction of thirty-seven constants into a mathematical equation, and the solution thereof, is facilitated by enormous tide-predicting machines. Such complex machines are in the possession of the U. S. Coast and Geodetic Survey and foreign agencies.

**River Tides and Currents.** The mutual interaction of tides and river currents is apparent wherever large streams discharge into coastal waters. The height of the tides in bays, rivers, and estuaries may be considerably increased by a strong outflow of marginal streams, swollen by hydrological run-off and by freshets due to melting snow. Conversely, the effects of ocean tides may extend as tidal currents far up a river. For example, in the Hudson River the effect of the tides is encountered at a distance of 131 mi. upstream from the river mouth. Tidal currents usually continue to move upstream until they encounter falls or rapids too strong to surmount. River currents produced at high water travel faster than those at low water, the maximum velocity of tidal currents being as much as 12 knots.

*Tidal Bore.* When water is constrained to move in a narrow channel under the action of a large vertical tide, a sizeable head of water results and moves upstream as a solid wall. This phenomenon is the tidal bore. Such bores occur mainly far upstream where both friction and downstream river current combine to present the greatest resistance to the approaching tides. A famous tidal bore occurs in the Bay of Fundy, situated between New Brunswick and Nova Scotia, Canada. At Moncton, New Brunswick, the Petitcodiac River empties into the Bay of Fundy as a marginal stream. At low water, it disgorges over mudflats and sandbars as a stream 500 ft. wide. With the approach of high tide, a solid wall of water more than 2,500 ft. wide advances up the river, as a hissing, turbulent eddy two or three feet high. The largest known tidal bore occurs on the Tsientang River, which flows into the China Sea; here the tidal bore rises to 10 ft. in height.

*Reversible Waterfall.* The reversible waterfall is another phenomenon associated with river tides. A typical example exists on the St. John's River, New Brunswick, Canada. Here, a narrow defile presents a constricted opening to the passage of tidal waters upstream into a basin located above the elevation of low tide, but somewhat lower than the elevation of high tide as produced in the narrow gorge. The conducting channel thus acts as a ridge over which the water falls. At low tide, the water flows normally from the upper basin, through the narrow passage and over the ledge to create a downstream waterfall. At high tide, however, the precipitous rush of water into the narrow gorge builds up a large head of water, from which the water flows into the upper basin to create an upstream waterfall. The flow continues until the two water levels are equalized, and the tide begins to fall, then reverses in direction and produces a downstream falls again. The average fall of water produced within the gorge is about 9 ft., but with the largest tides the outward fall may be over 16 ft. high, and the inward fall over 12 ft.

**Greatest Tidal Ranges.** The highest tide in the world is that achieved under strong current conditions at Minas Bay, an inlet of the Bay of Fundy, in Canada. The tide curve exhibits the normal, semi-daily type. Often the tide rises to a height of over 40 ft. in six hours, falling as much in the succeeding six hours. In the case of spring tides, with perigee and maximum declination of moon combining their effects around a certain day, the range of tide is likely to be 50 ft. This exceptional tidal rise and fall is caused partly by the funnelling effect of the Bay of Fundy, whereby the depth of water decreases and the shorelines converge as one travels upstream. This is the least of three reasons for the large range, the others involving a technical discussion of the theory of tides, waves, and oscillations.

The following list indicates the height of tides at a few selected ports around the world. This list is from recent tide tables (which vary somewhat from year to year).

List of Selected Ports with Their Tidal Ranges and High-water Intervals

| *Port* | *High-water interval* | *Mean range* | *Spring range* |
|---|---|---|---|
| | h m | ft. | ft. |
| Cape Morris Jesup, n. Greenland | 10 49 | 0.4 | 0.6 |
| Reykjavik, Iceland | 4 50 | 9.1 | 12.0 |
| Koksoak River, Ungava Bay, Hudson Strait | 8 56 | 25.1 | 33.4 |
| St. John's, Newfoundland | 7 12 | 2.5 | 3.4 |
| Burntcoat Head, Minas Basin, Bay of Fundy | 0 9 | 39.4 | 44.3 |
| Portland, Me. | 11 10 | 8.9 | 10.2 |
| Boston, Mass. | 11 16 | 9.5 | 11.0 |
| New York (the Battery), N.Y. | 8 15 | 4.4 | 5.3 |
| Baltimore, Md. | 6 29 | 1.1 | 1.3 |
| Miami Beach, Fla. | 7 37 | 2.5 | 3.0 |
| Galveston, Tex. | 5 7 | 1.0 | 1.4 di. ra. |
| Maraca Is. Anchorage, Brazil | 6 0 | 22.9 | 30.0 |
| Rio de Janeiro, Brazil | 2 23 | 2.5 | 3.5 |
| Callao, Peru | 5 36 | 1.8 | 2.4 |
| Balboa, C.Z. | 3 5 | 12.6 | 16.4 |
| San Francisco (Golden Gate), Cal. | 11 40 | 3.9 | 5.7 di. ra. |
| Seattle, Wash. | 4 29 | 7.6 | 11.3 di. ra. |
| Nanaimo, B.C. | 5 0 | . . . | 11.2 di. ra. |
| Sitka, Alaska | 0 7 | 7.7 | 9.9 di. ra. |
| Sunrise, Cook Inlet, Gulf of Alaska | 6 15 | 30.3 | 33.3 |
| Honolulu | 3 41 | 1.2 | 1.9 di. ra. |
| Papeete, Tahiti I. | ..... | 0.8 | 1.1 |
| Darwin, Australia | 5 0 | 14.4 | 20.3 |
| Melbourne, Australia | 2 10 | 1.7 | 1.9 |
| Rangoon, Burma | 4 26 | 12.8 | 16.3 |
| Zanzibar, Africa | 3 28 | 8.1 | 11.9 |
| Capetown, So. Africa | 2 55 | 3.2 | 4.3 |
| Gibraltar | 1 27 | 2.3 | 3.1 |
| Granville, n. France | 5 45 | 28.5 | 40.2 |
| Leith, Scotland | 2 8 | 12.2 | 16.1 |
| London Bridge, Thames R. | 1 18 | 18.6 | 21.5 |
| Dover, Eng. | 11 6 | 14.5 | 18.6 |
| Avonmouth, River Severn | 6 39 | 31.1 | 40.4 |
| Ramsey, Isle of Man | 10 55 | 17.2 | 23.5 |
| Oslo, Norway | 5 26 | 1.0 | 1.1 |
| Hamburg, Germany | 4 40 | 7.3 | 7.8 |

(di. ra. = diurnal range)

**Wind and Weather.** Winds may have considerable effect in modifying the normal rise and fall of tide. A wind coming from the ocean toward the shore has the effect of raising the water level, by initiating a current that carries the water landward. High tides are thus increased over the average, while the low tides are also higher than average. A wind blowing from the land toward the ocean has the effect of lowering the water level by carrying the water away from the coast.

The effect of increasing barometric pressure over an extended surface of water is to diminish the level of the water due to the additional superincumbent weight of the atmosphere. As the barometric pressure rises one inch, the level of the water is depressed about 13 inches. A fall in the barometric pressure produces a corresponding rise in the level of the water. The combination of an extreme drop in atmospheric pressure together with winds of hurricane force can, therefore, produce appreciable heads of water. The so-called tidal wave is in no way the outcome of tidal forces, and lacks the required periodicity of tidal phenomena. This occurrence is in general caused either by violent storms of hurricane intensity or by deep-seated earthquake disturbances generated in the ocean floor, in which case they are called *seismic sea waves.*

**Harnessing the Tides.** This matter has long been the subject of debate in terms of practicability for power production when existing stores of coal, gasoline, and other hydrocarbon fuels are exhausted. Although four methods for utilization of tidal energy have been visualized, the most practical is the tidal basin system. In this system, the rise and fall of the tides is exploited by a suitable system of gates and sluices, so that a constant head of water is maintained from which to generate power. The amount of energy capable of production by this means is a direct function of the area of the capture-basin and the potential head of water. This latter factor is, in turn, a function of the range of the tides. The available head of water is by far the most important question in power production, although the size of the capture-basin is also an important factor in constructional costs.

Serious consideration has already been given to the possibility of construction of such tidal power plants on the Severn River in England, where a tidal range of more than 20 ft. is theoretically capable of producing 28,800 hp. of energy for each square mile of water impounded. A theoretical power output of 500,000 hp. could also be achieved in the tidal conditions at Passamaquoddy, Maine. However, the financial costs of constructing basins of adequate size for effective production of power to replace or supplement existing sources is a major drawback. Factors involved in the variation in the height of the tides, in the times of succeeding high tides, in the available head of water, and in the potential power output available contribute to the problems that interfere with utilization of tidal energy for practical purposes. F. J. Wo.

**TIDYTIPS,** a handsome member, *Layia platyglossa,* of the family Compositae. This annual grows about 1 ft. high and bears showy flower heads having numerous rays, bright yellow with white tips. This annual is found growing in the foothills and valleys of southern California, and two members of the family, both natives of the Pacific states, are cultivated as ornamental plants. They are the yellow tidytips, *L. elegans,* and the white tidytips, *L. glandulosa;* the former is characterized by yellow or white-tipped rays, while the latter has white or rose-tinted rays. M. G. W.

**TIECK, JOHANN LUDWIG** [ti'k] (1773-1853), German poet, storyteller, and critic, was born in Berlin, May 31, 1773, the son of a ropemaker. Tieck studied at the Universities of Halle, Göttingen and Erlangen, concentrating on English literature, especially of the Elizabethan period. He remained a student and admirer of Shakespeare and his times throughout his life, but his comprehensive work on the subject, full of bold, untenable conjectures, was never completed. In 1794 he entered the service of the Berlin publisher and rationalist writer C. F. Nicolai, whose narrative series, *Straussfedern,* he continued with tales chiefly of a satiric, didactic-rationalistic bent, in striking contrast to his earlier exotic, highly imaginative works, among which was *Almansur,* 1790. This blending of rationalism and Romanticism persisted throughout his life.

*LUDWIG TIECK*

FROM A PAINTING BY JOSEPH STIELER

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Tieck's principal writings are the melancholy, epistolary novel *William Lovell* (1795-1796) and the *Volksmärchen* (1797). The latter contained stories retold from chapbooks of the fifteenth and sixteenth centuries, partly in narrative form, for example *Die schöne Magelone,* and partly in dramatic form, for example *Ritter Blaubart* ("Knight Bluebeard") and *Der gestiefelte Kater* ("Puss in Boots"); it also contained original tales of a highly imaginative, weird nature, notably *Der blonde Eckbert,* translated into English by Carlyle. He attempted to counteract the prevailing Rationalism, of which Nicolai was an extreme representative. The *Volksmärchen* attracted the attention of the Schlegels, especially August Wilhelm, who proclaimed Tieck a "Romantic" poet. In 1799, Tieck found a friend in the Romantic author Friedrich von Hardenberg, who was called Novalis, and began his *Romantische dichtungen* (1799-1800), in which the typically Romantic panorama in dramatic form, *Leben und Tod der heiligen Genoveva,* appeared. In 1804 was published the amorphous drama *Kaiser Octavianus,* considered by Tieck the best example of his "Romantic manner."

In 1802 Tieck and his family became guests of Count von Finchenstein on his estates in the Neumark near Frankfurt am Oder. There he remained until 1819, though with interruptions that included a visit to England in 1817, preparing modernized versions of German medieval poems (*Minnelieder aus dem schwäbischen Zeitalter,* 1803), collections of Elizabethan plays (*Altenglisches Theater,* 1811), and an edition of German dramas of the sixteenth and seventeenth centuries (*Deutsches Theater,* 1817). He also began a collection of some of his earlier Romantic works, which were published as *Phantasus* (1812-1816), linking them with clever conversations recalling Boccaccio's *Decameron,* and adding some new works, among them *Fortunat,* in the same manner.

In 1819 Tieck settled with his family in Dresden, where from 1825 to 1830 he served as dramatic adviser to the royal theatre. Here he turned away from Romanticism and wrote a long series of *Novellen,* in which the usually realistic plot is subordinated to an often didactic discussion of social and literary questions. *Die Gemälde* (1821) and *Der Lebens Überfluss* (1837) are characteristic *novellen;* others, dealing with historical material, include *Dichterleben* (1826), a story of Shakespeare's youth, and *Der Aufruhr in den Cevennen* (1826). Tieck's last important work, *Vittoria Accorombona* (1840), is a novel of the Italian Renaissance. He also wrote many fugitive articles during this time and edited the continuation, made by Count W. H. von Baudissin and his own daughter Dorothea, of the A. W. Schlegel translations of Shakespeare. In 1842 he was summoned to Berlin by the Prussian king, Frederick William IV, and supervised performances of ancient Greek and Elizabethan dramas. From 1820 to 1840 his works had considerable influence upon English and American literature. Tieck died in Berlin, Apr. 28, 1853. E. H. Z.

**TIEN, THOMAS** [tɪɛ'n] (1890- ), cardinal priest, Archbishop of Peiping, was born Sept. 27, 1890, at Changtsiu, China. After ecclesiastical studies in the Seminary of the Divine Word at Yen-chew-fu, he was ordained priest in 1918, and in 1931 made his profession in the Society of the Divine Word, a missionary religious congregation. Having filled important administrative posts from 1932 onward, he was consecrated titular bishop of Ruspe in 1939, and in 1942 was named vicar apostolic of Tsingtao. He was among the thirty-two cardinals created in the consistory of Feb. 18, 1946. By a decree of Apr. 11, 1946, the Holy See raised the church in China from missionary to hierarchical status, establishing twenty ecclesiastical provinces, each headed by a metropolitan archbishop, and seventy-nine suffragan sees to be governed by as many bishops ordinary, and retaining thirty-eight prefectures apostolic. On May 10, 1946, Cardinal Tien was named first archbishop of Peiping and became the highest ranking prelate in China. W. C.

**TIEN SHAN** [tɪɛ'n shɑ'n], a mountain range in Sinkiang, China, and the southern Soviet Union. The longest range in Asia north of the Himalayas, it extends for 1,500 mi. northeastward from the Pamir Knot to separate the Dzungarian region from the Tarim basin. The range averages 250 mi. in width and covers an area of 400,000 sq. mi. The relief is broken and jagged, reaching 23,620 ft. in the Tengri Khan in the center and 17,946 ft. in the Bogdo Ula in the east. Glaciers are found in several parts of the range, particularly in the west; but the rivers, though rushing in places, assume no great size. The slopes are forested when exposed to moisture-bearing winds, but are covered with grass in the rain shadows. The climate is dry and clear for the most part. The range was uplifted in some former time, then worn down to a flat surface, or peneplain, and then uplifted again to about 20,000 ft. elevation. The present mountains are second-cycle mountains into which the present-day rivers are eroding valleys. There is considerable earthquake activity at the borders of the range. Oil has been found at Wusu in Sinkiang. There is considerable settlement in the lower valleys of the range where irrigation is possible. During the summer, transhumance is practiced on the grassy higher slopes. There is little industry in the Tien Shan beyond the small native crafts. J. E. V.

**TIENTSIN** [tɪɛ′njɪ′n; tɪ′ntsɪ′n], a city in Hopeh Province, in northeastern China, one of the largest and most important cities in China. Tientsin is located at the confluence of the Pei Ho and the Grand Canal, which drain the vast and fertile Hopeh alluvial plain. From Tientsin the confluence, known as the Hai Ho, flows eastward and enters the Gulf of Chihli (Pohai) at Taku, about 35 mi. from Tientsin. Tientsin is at the junction of the Tientsin-Pukou and the Peiping-Mukden railways, and is about 86 mi. southeast of Peiping.

Since early times, Tientsin has been a center of economic activity in northern China, and in 1860 Great Britain, recognizing the fact, obtained economic concessions in the city. The British were followed by France, Belgium, Japan, Italy, Germany, Russia, and Austria-Hungary, all of which obtained concessions. During the Boxer Rebellion in 1900 the Boxers laid siege to the foreign concessions for twenty-seven days until combined military forces of the United States, Great Britain, France, Germany, Russia, and Japan relieved the beleaguered concessions and forced a lifting of the siege. The Russian concession was surrendered by the Bolsheviks during the Russian Revolution, and the German and Austro-Hungarian concessions were taken over by the Chinese at the end of World War I. All other concessions, excepting the Japanese, were relinquished in the years after 1932; the Japanese were in Tientsin until 1945. In November 1931, shortly after the Mukden Incident, the Japanese instigated an uprising in Tientsin and in the ensuing confusion smuggled their puppet, Henry Pu-yi, who had been living under Japanese protection in Tientsin, into Manchuria where he was made executive head and, later, emperor of the Japanese-dominated state of Manchukuo. Fighting between China and Japan broke out in 1933 in Hopeh and Chahar provinces but was soon terminated by an armistice. Four years later Japan began a wholesale attack on China and captured Tientsin on July 31, 1937. The city was occupied by the Japanese until late in 1945. During the Chinese Civil War Tientsin was captured by the Chinese Communists in January 1949.

The city has well-paved roads, many modern buildings, and more than 700 factories, including carpet and rug factories, cement works, flour mills, and iron works. It handles at least ten per cent of China's trade: exports include hog bristles (largest single item), furs, egg products, raw cotton, cow hides, straw braid, and wool; imports include cotton and woolen piece goods, machinery, railway material, manufactured metals and minerals, and electrical appliances. Tientsin's port is the harbor of Tangku in the city of Taku at the mouth of the Hai Ho. Because of the volume of foreign trade, the condition of the harbor is of paramount importance to Tientsin, as the silt-filled Hai Ho presents a continuing challenge to river navigation. Most seagoing vessels are obliged to dock at Tangku; shallow-draught lighters are employed to carry goods up and down the Hai Ho between Tientsin and the port. The Japanese constructed the Tangku harbor in 1940, and the Chinese later developed it further. Three breakwaters protect the harbor; the wharf frontage of almost 2 mi. includes berths for vessels up to 350 ft. in length, with draughts up to 14 ft. In the winter icebreakers are used to keep the river and port free of ice.

Temperatures at Tientsin range from a maximum of 107° F. to a minimum of −3° F. with the annual mean temperature about 52° F. Annual precipitation averages about 20 in.

The city wall around Tientsin, erected in the early fifteenth century, was torn down in 1901 at the direction of the international commission that governed the city for several years after the Boxer Rebellion. Many temples stand in the city, including one to Li Hung-chang, nineteenth-century Chinese statesman, governor, and military leader. Tientsin is an educational center and its many institutions of learning include Nankai University, a teacher's college for women, and an engineering school. Pop. 1947, 1,686,543.

A. C. T.

**TIEPOLO, GIOVANNI BATTISTA** [tyɛ′polo], called "Giambattista," (1696-1770), Venetian painter and etcher, was born in Venice in March 1696, the son of a well-to-do merchant mariner. He received his earliest instruction from Gregorio Lazzarini, a minor painter then of some repute, and through Sebastiano Ricci came to understand the Venetian decorative tradition. His first work was influenced by his slightly older contemporary, G. B. Piazzetta, whose solid construction and sharp oppositions of light and dark were derived from the Bolognese and Roman baroque painters. From these sources Tiepolo created and refined his superbly dexterous and decorative art. In such ceiling paintings as the *Institution of the Rosary* (1739, Venice, Gesuati) and the *Transportation of the Holy House to Loreto* (1743-1744, Venice, Scalzi), Tiepolo established the formula for the Venetian rococo. Spacious and delicately symmetrical

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*APOTHEOSIS OF THE SPANISH MONARCHY*

*Detail of a ceiling fresco executed by Giovanni Battista Tiepolo for Charles III of Spain*

compositions of many dramatically foreshortened figures, seen from below and developed to dizzying heights in illusionistic perspective, are painted in his exquisite, pale tonalities. His fame quickly spread from Venice to the mainland. Between 1726 and 1761 he executed many important commissions for churches and palaces in Udine, Milan, Bergamo, Vicenza, and Verona. In 1750 he was summoned to Bavaria by the Prince-Bishop of Würzburg, where with his sons he decorated the throne room and stair hall of the palace. In

1757 he returned to Venice and in 1758 was elected first president of the Academy of Painting and Sculpture. In 1761 he was called by Charles III to Madrid where, again with his sons, he worked on the decoration of the new royal palace until his death on Mar. 27, 1770.

Tiepolo's easel paintings are relatively few in number in comparison with his countless brilliant drawings, assiduously collected and preserved by his friend, Count Algarotti. As an etcher he is best known for the ten plates of the *Capricci* and the twenty-one *Scherzi di Fantasia.* Of his two painter sons, Lorenzo (1736-1776) continued his father's manner in Madrid, while Giovanni Domenico (1727-1804), returning to Venice, maintained the family tradition in a somewhat drier manner, affected by the nascent Neoclassic movement. He was also an etcher and published many plates after his father's compositions. G. H. H.

**TIERCERON.** *See* Architectural Terms.

**TIERRA DEL FUEGO** [tyɛ'rrɑ thɛl fwe'go], an archipelago at the extreme tip of South America, separated from the continental mainland by the Strait of Magellan. The area of approximately 28,000 sq. mi. is divided between Chile on the west and Argentina on the east by a line through 68° 34′ W. long. On the south and west of Isla Grande (or Tierra del Fuego) are many small islands. Staten Island (Isla de los Estados) belongs to Argentina. Picton, Nueva, and Lennox islands are claimed by both Argentina and Chile. The larger islands belonging to Chile are Navarino, Hoste, Dawson, Clarence, Santa Inés, and Desolación. The climate is cool, stormy, and wet. Forested and snow-clad mountains reach elevations of over 7,500 ft. Along the strait and on the southern coast, rich peat soils support vast areas of steppe grasses, used for sheep grazing. Of a total population of approximately 7,200 Scots, Yugoslavs, and Spaniards, Porvenir (Chile) has 2,000 and Ushuaia (Argentina), the world's southernmost town, has under 2,000, of whom half are confined in the penal settlement. The native Yagan and Ona Indians have almost disappeared. P. E. J.

**TIFFIN** [tr'fɪn], a city in northern Ohio, county seat of Seneca Co., situated on the Sandusky River in the center of an agricultural area, 80 mi. southwest of Cleveland. Natural resources of the region are oil, limestone, and dolomite stone. Founded in 1821, Tiffin was incorporated as a city in 1835. The community is governed by a mayor and council. A feature of historic interest is Fort Ball, one of a chain of forts erected during the War of 1812. Tiffin is the seat of Heidelberg College and Tiffin University, a business college. The Tiffin State Hospital for mental diseases is in the city. Transportation is afforded by the New York Central, the Pennsylvania, and the Baltimore & Ohio railroads. Highly diversified manufactures include machine products, electrical machinery, motors, grinding wheels, brass and bronze castings, copper wire, burial vaults, church furniture, sanitary pottery, and dairy products. Pop. 1950, 18,952.

**TIFLIS.** *See* Tbilisi.

**TIFTON,** a city in south central Georgia, the county seat of Tift Co., located about 85 mi. south of Macon. Founded in 1889 and incorporated in 1890, the city has the council-manager form of government. Tifton is the seat of Abraham Baldwin Agricultural College and the Georgia Coastal Plain Experiment Station. Tobacco, peanuts, cotton, corn, melons, and flowers and plants are grown extensively in the fertile countryside surrounding the community. Livestock and bees are also raised, and large quantities of bees and plants are shipped from Tifton, which has rail service provided by the Atlantic Coast Line and Southern roads. The local industrial establishments include lumber, chemical, peanut, and tobacco-stemming plants, cotton and cottonseed-oil mills, and a packing house. Pop. 1950, 6,831.

**TIGER,** a large striped cat, *Felis tigris,* of Asia. It is the largest known cat, males of the Siberian species attaining a length of 14 ft., and exceeding in weight the largest lion. Several races occur, varying chiefly in size and color. While greatly reduced over their former abundance, tigers in the period following World War II were still widely distributed in Asia, from the tropical bamboo jungles of Malaysia to the snow-swept plains of Siberia. They differ only in thickness of coat, all possessing the characteristic black stripes on a yellow background. The tiger is more powerful, and certainly more ferocious, than the lion, and the loss of thousands of lives has been attributed to it. Man-eaters are usually old tigers that find it easier to stalk and kill a human rather than to attack another beast.

YLLA

*TIGER,* FELIS TIGRIS

Tigers are solitary animals, usually dwelling near a watercourse. They are adept swimmers. Their food consists of the water buffalo, antelope, cattle, or even native dogs, although when pressed by hunger the tiger will take frogs and other small animals. The tigress has two to six cubs a year, usually three. She cares for them until they are about three years old. Once abundant in northern China, the tiger has been hunted until it has almost become extinct. The thick winter coat is valued at a high price in the fur market. The Chinese impart a high value to the carcass, believing that the bones, blood, heart, and flesh have rare therapeutic values. The heart of the tiger is supposed to impart to the consumer the courage and strength of the tiger itself. The tiger thrives in captivity. Hybrids resulting from a mating of a lion with a tiger have been bred. W. J. Ha.

**TIGER BEETLE,** the name given to any member of the family Cicindelidae, in the order Coleoptera. The tiger beetles are predaceous upon other insects and are provided with long legs that enable them to run swiftly over the ground. Their jaws are long and strong. They are alert and

wary and take to flight readily, but they usually fly only short distances. The larvae live in tunnels in the ground, where they await passing insects. The larvae are provided with a pair of forwardly directed hooks on the posterior third of the body that prevent them from being dragged from the tunnels by their prey. C. H. Cu.

**TIGER CAT.** *See* MARGAY.

**TIGERFLOWER,** a common name given to any plant of the genus *Tigridia* of the iris family. They are bulbous herbs native from Mexico to Chile. *T. pavonia* is frequently cultivated for the brilliance of its flowers. The narrow stem, to 2½ ft., bears alternate leaves and leaflike spathes bearing large red flowers spotted with red and purple markings. The flowers are fugacious, lasting only one day and succeeded by others. There are many horticultural varieties of the tigerflower. Bulbs planted in late spring will bloom in July or August. The corms should be lifted before the frost and stored in a dry place over the winter months. C. R. Eb.

**TIGER LILY.** *See* LILY.

**TIGER'S EYE,** or crocidolite, a variety of amphibole. It is a fibrous asbestos-like mineral, a silicate of sodium and iron, $NaFe(SiO_3)_2 \cdot FeSiO_3$. Some calcium or magnesium may enter into the composition. Crocidolite has a hardness of 4, a density of 3.20. The mineral crystallizes in the monoclinic system. In fibrous form the mineral has a mean index of 1.687. Crocidolite, which is blue in the asbestos state, becomes a hard golden-brown or brown mineral when replaced by ferruginous silica. The mineral in this form can be cut and carved to bring out the chatoyant effect to which the name tiger's eye has been given. Tiger's eye crocidolite must not be confused with one variety of the mineral chrysoberyl which is known as cat's eye. Here, the chatoyancy is due to structural differences within the mineral which are in no way akin to the fibrous structure which characterizes crocidolite. This semiprecious gemstone is obtained from Griqualand, South Africa. A. E. A.

**TIGER SHARK,** *Galeocerdo arcticus,* a large cosmopolitan shark, in the family Carchariidae. It is identified by the sickle-shaped teeth with serrate edges which are alike in both jaws. One of the largest sharks, it has been reported to reach 30 ft., although it is rarely over 20 ft. The tiger shark is found in warm oceans and, in the Atlantic, strays northward to Cape Cod. This voracious creature eats almost any kind of animal life, including other sharks, and is distinctly dangerous to man. It may bear as many as 57 living young. Its very tough skin is made into leather and the liver yields a valuable vitamin-bearing oil. A specimen 14 ft. long and 1,382 lb. in weight was taken on rod and reel off Australia. E. C. R.

**TIGRIS** [tai'grɪs], an important river of the Near East. About 1,150 mi. long, it rises in southeastern Turkey in Lake Gölcük, from which it flows, as the Dicle Nehri, in a generally southeastward direction. It forms a borderline at northeastern Syria and then, as the Tigris, continues across the entire length of Iraq, joining the Euphrates in southern Iraq, north of Basra, to form the Shatt al 'Arab, which flows into the head of the Persian Gulf. There is evidence, however, that in Sumerian times the river flowed in a more westerly channel, closer in its lower course to the Euphrates, with which it was connected by canals, some of which remain. The two large rivers have always been the water supply of semiarid Mesopotamia. The Tigris is swifter than the Euphrates and more important commercially, for much of it is navigable by flat-bottom river boats, permitting extensive local trade. Below Baghdad, cargoes are carried by river steamers, which connect with the modern railway terminus as the barges of old did with the caravan routes from the East.

The ruins of Nineveh, capital of ancient Assyria, lie on the banks of the Tigris, which was undoubtedly one of the avenues of attack used by the Babylonians and their allies in their destruction of the city in 612 B.C. The conquering Romans also made use of the Tigris when Emperor Trajan traversed the length of the river in his rout of the Parthians (A.D. 115-117). Among other ruins on the river are those of Seleucia, Calah, and Ctesiphon, which regained prominence during World War I as a battle site of the British Mesopotamian Campaign. The important modern towns on the Tigris, from north to south in Iraq, are Mosul, Samarra, Baghdad, and Kut al Imara. J. E. F.

**TIHWA** or **URUMCHI** [di'hwɑ', uru'mtshi], the capital of Sinkiang Province, in northwest China, located in an oasis on the Urumchi River, north of the Tien Shan range, about 300 mi. southeast of Tahcheng (on the border between Sinkiang and the Soviet Union) and 300 mi. northwest of Hami. The city has a continental desert climate with bitter cold, dry, windy winters and hot, dry summers with occasional showers. Since the source of atmospheric moisture for the Tihwa area is the distant Atlantic Ocean, only a few inches of rain fall annually; but the spring run-off of ice and snow from the near-by mountains and the ground water seepage forming springs along the foot of the mountains provide enough moisture for the fertile and productive oasis in which the city is situated. Tihwa has always been an important juncture of caravan routes from Siberia, India, and the west. The city's residents represent a racial mixture of Turks, Chinese Mohammedans, Mongols, and Chinese of the Han race. The Chinese influence reached Tihwa as early as 122 B.C. when Wu Ti of the Han Dynasty conquered the eastern section of Sinkiang. During the Mohammedan Uprising in Sinkiang (1862-1877) the Manchu emperor suppressed the revolt, and as a result in 1882 Sinkiang was formally proclaimed a province of China, with Tihwa its capital. The modernization of Tihwa did not commence until after the first decade of the twentieth century. The first telegraph line reached the community in 1913 and its first radio station as late as 1930. The city's educational institutions include Sinkiang Provincial College. Economically, Tihwa is an important agricultural, mining, and trade center for Sinkiang. To the immediate northwest, near Suilai, rice is grown in large quantities. Coal is found near Tihwa at Shuimokow and Toutungchang; petroleum at Ssupenkow and Sutachang; and silver and copper at Chai-o-pao. Tihwa's industries include tanneries, flour mills, and power plants. The city serves as a market and distribution center for furs and skins, wool, carpets, livestock, and gold. Pop. 1947, 69,991. A. C. T.

**TIJUANA** or **TIA JUANA** [tihwɑ'nɑ, ti'ɑ hwɑ'nɑ], a resort town in northwestern Mexico. It is located just south of the Mexican-United States border in the northern part of the state of Lower California. Tijuana is a favorite sporting center for American tourists, particularly during the racing season. Pop. 1940, 16,486. A. L. R.

**TIKHON'KAYA.** *See* BIROBIDZHAN.

**TILBURG** [tɪ'lbɜrχ], an industrial town in the province of North Brabant in the southern Netherlands, 60 mi. southeast of Amsterdam. It became a town in 1809, during the French period, when it was elevated to that rank by King Louis of Holland, the brother of Napoleon. It is known for its important wool and textile industry and leather factories. The Wilhelmina Canal, built in 1920, contributed greatly to the prosperity of the town. In the early nineteenth century Tilburg was the residence of King William II of the Netherlands, whose palace is now used as the town hall. Pop. 1952, 124,545. B. L.

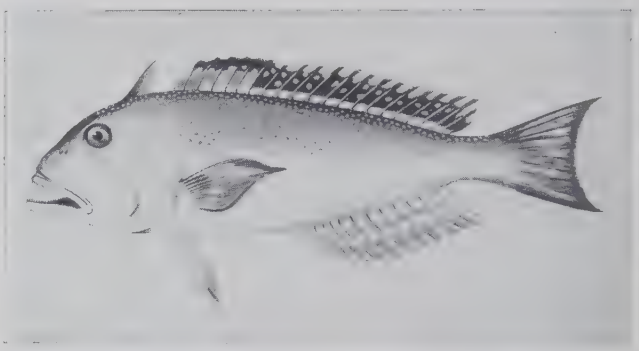
**TILBURY,** a town on the boundary of Essex and Kent counties, Ontario, Canada, 32 mi. east of Windsor, on Provincial Highways 2 and 98. It is served by the Canadian Pacific and the New York Central railways. Tilbury was incorporated in 1910. The surrounding area is well suited for the production of farm crops, especially corn, wheat, soybeans, tomatoes, beans, tobacco, and onions. The industrial products of Tilbury include canned goods, motor cars, furnaces, and dairy products. Pop. 1951, 2,682. D. F. P.

**TILDEN, SAMUEL JONES** (1814-1886), governor of New York and Democratic presidential candidate in the disputed election of 1876, was born at New Lebanon, N.Y., Feb. 9, 1814. He was educated at Yale University, and at New York University, where he graduated in 1837. He studied law at the latter institution, then called the University of the City of New York, and was admitted to the bar in 1841. In New York he quickly became a noted figure in Democratic politics. In the split among the Democrats after James K. Polk's election in 1844, Tilden was aligned with the anti-slavery group called "Barnburners." Thereafter until the post-Civil War period his influence in Democratic politics was slight. Meanwhile he won a distinguished reputation as a lawyer, particularly as counsel to railroads in process of reorganization. In 1867 he was elected a delegate to the New York State constitutional convention. He was also chairman of the Democratic state committee and began his long and successful fight against the Tweed Ring. He became a national personality and was chosen governor of New York in 1874. In 1876 he won the Democratic presidential nomination. In the election that followed, Tilden won a popular majority of 250,000, but lost the presidency to Rutherford B. Hayes by one electoral vote after a special electoral commission had been set up to determine the victor. His political activity thereafter declined. On his death he left a substantial bequest for the establishment of the New York Public Library. He died in New York City, Aug. 4, 1886. M. K.

**TILDEN, WILLIAM TATEM, II** (1893-1953), American tennis player, was born in Germantown, Pa., Feb. 10, 1893. He began to play tennis in his early boyhood, winning his first tournament at the age of eight. By the time he entered the University of Pennsylvania he was a nationally known competitor, and in 1913 he scored his first important victory by teaming with Mary K. Browne to win the national mixed doubles championship. In 1918, with Vincent Richards, he took the national doubles title, and in the following year he was runner-up to William M. Johnston in the national singles championship. Tilden won the singles title for the first time in 1920 and for almost a decade thereafter was the dominant figure in American tennis. In 1920 he was also a member of the Davis Cup team that brought the world championship trophy back to the United States from Australia, and he was the foremost player on the teams that successfully defended the cup until 1927, when it was lost to France. After holding the national singles title from 1920 through 1925, Tilden lost it to René Lacoste of France, although he regained it for a year in 1929. He was three times Wimbledon champion, and he won many lesser titles in the United States and abroad. In 1930 Tilden turned professional and won several national professional championships during the following two decades. He died in Hollywood, Calif., June 5, 1953. G. Q.

**TILE.** *See* Engineering Materials (*Brick and Clay Products*).

**TILE FISH,** *Lopholatilus chamaeleonticeps,* a large, bass-like fish in the family Malacanthidae, which possesses a large fleshy flap on the nape and a barbel at the corner of the mouth. This beautiful fish is colored green or blue above



COURTESY OF THE U. S. FISH AND WILDLIFE SERVICE

*TILE FISH,* LOPHOLATILUS CHAMAELEONTICEPS

and yellow or red on the lower sides. Its habitat is limited to the outer edge of the continental shelf along the east coast of the United States from Maine to Virginia. It lives in depths of 50 to 200 fathoms, but the best fishing is at 60 to 65 fathoms. Crabs are its main food but it also eats many other invertebrates and some fish. First discovered in 1879, it almost immediately became the support of an important fishery. It is delicately adapted to a narrow range of water temperatures of 47° to 50° F. In 1882, the population was reduced almost to extinction by a great kill due probably to a marked change in water temperature. It gradually increased until 1917 when about 11,500,000 lb. were taken in one year. Although an excellent food fish, the market demand has decreased to a point where relatively few are now taken commercially. It reaches a weight of 50 lb. E. C. R.

**TILL,** the unsorted, unconsolidated debris deposited by glacier ice. It consists of an unstratified mixture of boulders, sand, and clay. The boulders may be scratched or grooved due to rubbing while in transit in the ice. Tillite is the name given to ancient till that has been cemented into rock. K. K. L.

**TILLAMOOK.** *See* Indian Tribes, North American.

**TILL EULENSPIEGEL.** *See* Eulenspiegel, Till.

**TILLOTSON COLLEGE,** an accredited, privately controlled, coeducational institution of arts and sciences and a teachers college for Negroes, affiliated with the Congregational and Christian Churches of America, at Austin, Tex. It started in 1881 as the Tillotson Normal and Collegiate Institute. The present name was adopted in 1909, when college work was added. The Home Economics Division was added in 1930.

Degrees offered are the A.B., the B.S., and the B.S. in home economics and rural education. Two-year courses in elementary education and commercial studies are also available. Some dormitory facilities and limited scholarships are provided. *For statistics see* COLLEGES AND UNIVERSITIES.

J. R. To.

**TILLSONBURG,** a town in Oxford Co., Ontario, Canada, 153 mi. northeast of Windsor, 103 mi. west of Niagara Falls, and 16 mi. north of Lake Erie. It is on Provincial Highway 3, and the Canadian Pacific, the Canadian National, the Wabash, and the New York Central railways furnish rail facilities. Early settlement was attracted by the available water power of the Otter Creek. Sawmills and gristmills were the first industries of the community. Powdered milk, butter, cheese, boots and shoes, barrels, garden tools, heavy machinery, furniture, and tobacco products are the town's chief products. Pop. 1951, 5,330. D. F. P.

**TILLY, GRAF VON (JOHAN TSERCLAES)** [tɪ'li] (1559-1632), Bavarian military commander, was born at Castle Tilly, Duchy of Brabant, in 1559. Although educated as a Jesuit, he served with the armies of Spain, Austria, and Bavaria. He distinguished himself in the Austrian campaign against the Turks in 1602. In 1610 he entered Bavarian service as General Field Marshal and ten years later became commander-in-chief of the forces of Maximilian I, Duke of Bavaria, head of the Catholic League. Tilly's victories in the course of the ensuing Thirty Years' War won him military fame throughout Europe, and he was made a count in 1622 after his victory at Höchst. The atrocities of his troops against the inhabitants of Magdeburg after its capture in 1631 and Tilly's complete sack of the city were the greatest single outrage in the entire war. After Wallenstein's dismissal, Tilly commanded the united imperial and league forces. He was decisively defeated by Gustavus II Adolphus in the Battle of Breitenfeld on Sept. 17, 1631. Mortally wounded on the banks of the Lech while fighting the Swedes, he died Apr. 30, 1632, at Ingolstadt, Bavaria.

R. H. L.

**TILSIT** [tɪ'lzɪt], an industrial and commercial town on the northern border of the Kaliningrad (Königsberg) Okrug, administratively under the Russian Soviet Federated Socialist Republic, located in the western Soviet Union, 60 mi. northeast of Kaliningrad, at 55° 5′ N. lat. and 21° 55′ E. long. Situated at the mouth of the Tilse River, on the left bank of the Nemunas (Niemen) River, it lies east of the Tilsit depression. Developed in the early fifteenth century around a castle of the Teutonic Order founded in 1288, the town received civic rights in 1552. It was the site of the signing in 1807 of the Treaty of Tilsit. Occupied by the Russians for 17 days in 1914, it was a center of German pressure against Lithuania in regard to Lithuanian occupation of the Memelland between World Wars I and II. After several months of fighting and heavy damage to the town during World War II, it was captured by Soviet troops on Jan. 20, 1944. Tilsit was transferred from German to Soviet control by the Big Three Conference at Potsdam in 1945. Notable edifices include the sixteenth-century church of the Teutonic Order, the eighteenth-century parish church, and the eighteenth-century town hall; there are also a museum, botanical garden, and theatre. The townspeople trade in lumber, grain, leather, horses, cheese, and other agricultural products. Manufactures include wood products (especially cellulose), distilled spirits, beer, chemicals, yeast, machines, leather goods, iron, tobacco products, cheese, and soap. Pop. (est. 1950), 50,000.

C. C. H.

**TILSIT, TREATY OF.** *See* FRANCE (*History*).

**TIMBER.** *See* ENGINEERING MATERIALS; INDUSTRIES, EXTRACTIVE (*Forestry Products*); LUMBER INDUSTRY; WOOD.

**TIMBRE, TONE COLOR,** and **TONE QUALITY** are terms used to describe that aspect of a sound which makes it possible for us to distinguish between a violin and an oboe, or between the different speech sounds. A simple tone has certain characteristics, such as pitch and loudness. The quality of a tone is a more complex phenomenon than either of these. The textbooks usually say that differences in quality arise from differences in the relative strength of the harmonics or overtones which go to make up the sound. For example, Dayton C. Miller in his *The Science of Musical Sounds* (1916) analyzed the sound waves of the standard orchestral instruments, and gave diagrams showing the relative loudness of the different harmonics. The diagrams are reasonably accurate so far as they go, but all such analyses assume that successive cycles of a sound wave are identical, and that therefore when a single cycle is analyzed into its composite elements, the resultant answer tells us what harmonics are "characteristic" of the entire tone. More recent experiments using electronic equipment seem to indicate, however, that the differences in successive cycles are not immaterial and accidental, but play an essential part in creating the quality. During World War II, the Bell Telephone Laboratories built an extremely elaborate apparatus for analyzing and recording sound waves. A report of some work done with this apparatus by Ralph K. Potter, and others, illustrated with numerous photographs of all the speech sounds, appeared in 1947 under the title *Visible Speech*. An examination of these photographs seems to indicate that the changes in the patterns of energy distribution may play quite as large a part in producing the quality as the harmonics themselves. In short, the timbre of a sound is a product of the harmonics present in that sound and of their changing patterns.

R. S. H.

**TIMBREL,** a term familiar largely from the Authorized Version of the Bible, where it denotes the Hebrew *tof,* a frame drum or tambourine.

W. Li.

**TIMBUKTU** or **TOMBOUCTOU** [tɪmbʌ'ktu, tɪ'mbʌktu'; tõ'bu'ktu'], a trading center of the French Sudan, in French West Africa, located near the great bend of the Niger River. Recent archaeological studies have revealed Egyptian architecture dating to prehistoric times, but more certain is the founding of the town toward the close of the eleventh century of the Christian Era by a native nomadic tribe called Tuareg.

A succession of dynasties controlled Timbuktu in the course of its history. The first two were native dynasties ruling from 1336 to 1433 and from 1433 to 1468. Then came the illustrious Songhai dynasty (1468-1528), inaugurated by Sunni Ali's bloody conquest of the town and characterized by the greatest extent and splendor the city ever knew. It was during this time that several mosques and the university were built and served as southernmost beacons of Islamic civilization. The Moroccan period (1590-1750) was initiated by the conquest under El Mansur, Sultan of Morocco. This period witnessed the decay of the city at the exploitive hands of the viceroys and through the plundering assaults of the Tuareg. Finally, in 1792, the Tuaregs once more held Timbuktu. During the fifteenth century the town carried on gold and salt trade with Europe via Tunis, Tripoli, and four caravan routes to Egypt, but it

subsequently declined in commercial importance and became known to Europeans as an almost legendary place. Nineteenth-century explorations rediscovered the town, and the French, expanding from Senegal, took it in December 1893.

The present town, populated mostly by Moslems, is not the city of Songhai times. French control has spurred the natives to rebuild houses and schools and to lay out new streets. A telegraph line links Timbuktu with Algeria. Salt trade, however, is still the principal economic activity. Pop. (est. 1949), 7,000. W. S. V.

**TIME.** The concept of time itself is seemingly incapable of definition, and such considerations are largely philosophic. This article is concerned with time as used in astronomy. For the adequate measurement of time it is necessary to have an ideal timekeeper of the highest accuracy by which to regulate timepieces. The most nearly ideal timekeeper is the earth's rotation, which is more uniform than the most accurate clock, with the possible exception of the quartz-crystal oscillator. The earth's rotation can be timed by observing the transit of a suitable celestial object over a particular meridian. A point on the celestial sphere is chosen, to mark the zero hour or beginning of a day, by the transit of that point over a given meridian; then the time at any other instant of the day is the hour-angle of the point at the instant. Time measure is really the measure of hour-angle or of earth rotation.

Astronomers recognize three principal kinds of time: sidereal, apparent solar, and mean solar. Other designations, such as Greenwich civil time, are subdivisions or different clock settings of the main types. The lengths of the units vary between sidereal and solar time, since the second, minute, and other dimensions of sidereal time are slightly shorter than the corresponding lengths of solar time; but in all divisions of solar time the second is of invariable length.

**Sidereal Time.** Sidereal time is nearly but not exactly "star time"; if a star is on the meridian at a certain moment, one turn of the earth on axis brings the star at exact transit over the same meridian. The interval between the two transits is the earth's rotation period, or 23 hr., 56 min., 4.099 sec. in mean solar time. Sidereal time, however, is measured by the diurnal motion of the vernal equinox and not by a star. A sidereal day at any place is the interval of time between two successive transits of the vernal equinox over the meridian of the place. This is shorter by 0.008 sec. than the earth's rotation period. Sidereal time is the hour-angle of the vernal equinox, and all places having the same longitude have the same sidereal time. When the vernal equinox is on an observer's meridian, his sidereal clock reads zero hours, minutes, and seconds.

Sidereal time is of use almost wholly in the astronomical observatory. The principal use is in connection with the determination of time from the stars. Another is the locating of an invisible object in the observatory telescope, using hour-angle and declination. The telescope is first set to the object's declination, and then to the hour-angle by the relation $t = \theta - \alpha$, where $t =$ hour-angle, $\theta =$ sidereal time, and $\alpha =$ right ascension. Also, sidereal time shows the vernal equinox's distance west of the meridian in hours, the right ascension of stars on the meridian, or the right ascension of other stars, as per formula above, and is a guide to the westward shifting of the stars at the rate of 2 hr. per month. It is likewise used by astrologers in their technical work.

**Apparent Solar Time.** Apparent solar time is measured by the diurnal motion of the actual sun on the celestial sphere. It is the time shown by the shadow on a sundial. An apparent solar day at any place is the interval of time between two successive lower transits of the sun over the meridian of the place. Apparent solar time is the hour-angle of the sun + 12 hr. (Before Jan. 1, 1925, an apparent day was the interval between two successive upper transits of the sun, and apparent time was the hour-angle of the sun. This point is of importance in using almanacs of date prior to 1925.)

The apparent solar day is divided into 24 hr., beginning with zero hour (0 hr.) at apparent midnight, when the sun is at lower transit. At apparent noon (12 hr. apparent time) the sun transits the upper meridian, and the shadow of a vertical object lies in a north-south line or meridian. Apparent days are not of the same length as sidereal days. If the sun and a star are on the meridian at the same moment, one sidereal day later the star will be in transit again; meanwhile the sun has moved eastward in its annual apparent motion along the ecliptic at about 1° per day. Hence, the sun transits about 4 min. later than the star, and a sidereal day is shorter than a solar day by 3 min. 55.909 sec. of mean time.

The sun is not a very good timekeeper, because its apparent motion is not uniform along the ecliptic. Hence the solar days vary in duration, and sundial instruments are the only ones adapted to apparent time; clocks cannot well be regulated to it. There are two causes for the lack of uniformity of apparent time. First, the sun's apparent annual motion is not uniform, for the sun goes fastest when the earth is nearest the sun and slowest when the earth is farthest away, on account of eccentricity of the earth's orbit. The inclination of the celestial equator to the ecliptic also affects the case. The sun's apparent motion is along the ecliptic, not along the equator. But measurement of time involves hour-angle, which is measurement from the meridian and is marked at right angles to the equator, and not to the ecliptic. At equinox times, solar movement of 1° along the ecliptic is projected as less than 1° on the equator, since the two circles are at an angle; whereas at solstice times 1° along the ecliptic is the same when projected to the equator, for here the two circles are parallel.

Apparent solar time is used in connection with the sundial, setting up a meridian by the plumb-line method, and observations on the sun for meridian altitudes, or in general any observation on the true sun.

**Mean Solar Time.** Mean solar time is measured by the diurnal motion of the "mean sun" on the celestial sphere. In one form or another, mean time is the kind of time in ordinary use. In order to avoid the lack of uniformity of the apparent solar day, a fictitious body (mean sun) is assumed to have a uniform, eastward motion along the celestial equator and to complete a revolution in the same time that the real sun takes for an apparent revolution around the ecliptic—that is, one tropical year of 365.2422 days. A mean solar day is the interval of time between two successive lower transits of the mean sun over the observer's meridian, and mean solar time is the hour-angle of the mean sun + 12 hr. (Before 1925, a mean solar day was the interval between two successive upper transits of the mean sun over the observer's meridian.) The mean solar day is divided into 24 hr., beginning with 0 hr., or mean midnight. At mean noon or 12 hr., the mean sun crosses the upper meridian. A mean solar day has the length of an average apparent day throughout the year. The mean sun moves westward daily, because of earth rotation, with a uniform angular motion. Like the actual sun, it is also in motion eastward with respect to the stellar background, so that the right ascension of the mean

sun increases at a uniform angular rate, each day of mean solar time being precisely of the same length.

**Civil Time.** Civil time refers to the special use of mean time that begins its day at midnight. Civil time is the same as mean solar time, that is, in kind of time; but the use of "mean" has been largely abandoned, as it is apt to confuse matters with the situation before 1925, when the astronomer's mean-time day began at noon. The civil day begins 12 hr. earlier than the old astronomical day of the same date; for example, 21 hr. astronomical time for June 18, 1924, equals 9 A.M. civil time for June 19.

All the kinds of time discussed so far are local, meaning that time for an observer at a given meridian is the true time at that meridian only. At any other meridian to the east, the time is later on the clock face than on the given meridian; and at any meridian to the west, the time is earlier on the clock. Time, so to speak, goes around the earth westwardly at the rate of 15° of longitude per hour, or 1° per 4 min. of time. The mean solar time of a particular point (and of its meridian throughout) is known specifically as the local civil time (L.C.T.) of that meridian. Each different meridian, varying by the least amount, has a different local civil time at any one moment. This kind of time is not used by timepieces in civil life.

The local civil time of the Greenwich meridian is called Greenwich civil time (G.C.T.) by many astronomers, and its beginning, 0 hr., occurs at midnight. Before 1925, the astronomers used Greenwich mean time (G.M.T.), beginning at noon, but the term has been largely abandoned (especially in the United States) in favor of G.C.T. in order to distinguish between days beginning at noon and at midnight. If an astronomer in the British Isles now wishes to designate the day beginning at noon, he calls it Greenwich mean astronomical time (G.M.A.T.). The term universal time (U.T.), in use among professional astronomers, is synonymous with G.C.T., which is still used extensively in navigation.

**Equation of Time.** The equation of time is a small numerical quantity of importance in astronomy and mathematical geography. It is not an equation but an interval of time, stated as plus or minus. The nonuniformity of apparent time brings about a constantly changing difference between apparent and mean time, and the equation of time is the difference in hour-angle, at any moment, between the real sun and the mean sun, that is, the difference between apparent and mean time, or the difference in right ascension of the true and mean suns. At times, the apparent sun is ahead of the mean sun, and at other times it is behind, varying from 0 to 16 min. "Ahead of" signifies greater hour-angle or westward diurnal movement, and hence an earlier meridian transit. The equation of time is used in two different forms ("mean minus apparent" and "apparent minus mean"); and authorities differ as to the form to be used. In most cases a writer uses the equation in one form only, disregarding the other. Some texts have completely reversed their former definitions. The value of one—at any instant—is the same as in the other, but the sign is changed.

*Mean Minus Apparent.* The mean minus apparent ($E_{m-a}$) form of the equation of time is the correction applied to apparent time in order to obtain mean time. It may be plus or minus at any moment. When the mean sun is "ahead of" the actual sun, mean noon occurs before apparent noon, the mean sun transiting the meridian before the real sun. This is the "sun slow" phenomenon. At a particular location, the local civil time would be greater on the clock face than a sundial would show, and the equation of time, $E_{m-a}$, is plus. But when the mean sun is "behind" the real sun, mean noon occurs after apparent noon, the sun itself transiting before the mean sun, giving the "sun fast" condition; here local civil time shows a lesser time than a sundial does, and the $E_{m-a}$ is minus.

The values of the equation of time for a certain day of the year vary by a number of seconds from year to year; but the pattern is the same, with a zero value four times a year, about April 15, June 14, September 1, and December 25. Exact values are supplied in most almanacs and ephemerides, but one must note whether $E_{m-a}$ or $E_{a-m}$ is given. $E_{m-a}$ is used in sundial reading, also in observing the sun's meridian transit, and in general for determining the civil time from apparent.

*Apparent Minus Mean.* The apparent minus mean ($E_{a-m}$) form of the equation of time is the correction applied to mean time in order to obtain apparent time. When the apparent sun is ahead of the mean sun, there is the "sun fast" condition and the sign of $E_{a-m}$ is plus; and when the apparent sun is behind the mean sun, the "sun slow" effect occurs, and $E_{a-m}$ is minus. One of the main uses of the apparent minus mean form of the equation of time is in navigation, and nautical almanacs tabulate the equation in this sense. Astrology also uses $E_{a-m}$ in order to convert civil time into apparent solar time.

**Standard Time.** A person traveling to any extent begins to encounter the effect of difference in local time. If an entire country set the clocks on local time, there would be a multiplicity of different time readings for a given moment; only the clocks along a meridian would keep the same time. In 1883, the United States adopted the system of standard time (invented by Dr. Charles F. Dowd), by which the country is divided into four zones, the clocks over a whole zone reading the same time to the second. The standard time so used is the local civil time of the standard-time meridian for a particular zone. In the United States, the last four of the following table are in use:

| *Zone* | *Central Meridian* | *Hours Earlier than Greenwich* |
|---|---|---|
| Atlantic standard time (A.S.T.) | 60° west | 4 |
| Eastern standard time (E.S.T.) | 75° west | 5 |
| Central standard time (C.S.T.) | 90° west | 6 |
| Mountain standard time (M.S.T.) | 105° west | 7 |
| Pacific standard time (P.S.T.) | 120° west | 8 |

Canada uses the five zones and also the 135th-meridian time or Yukon standard time, 9 hr. earlier than Greenwich. There is also a Newfoundland standard time, 3 hr. 30 min. earlier than Greenwich. Alaska has four zones, those centered on meridians 120°, 135°, 150°, and 165° W. long. Mexico, though located geographically mostly within the 105th-meridian belt, uses 90th-meridian time except in part of Lower California.

The standard-time zones theoretically should be bounded by straight lines each 7½° from the central meridian; but practically they vary considerably from the ideal, mostly to accommodate railroad schedules. Standard-time boundaries in the United States are controlled by the Interstate Commerce Commission.

*Zone Time.* Zone time is the standard-time system applied to the entire globe, and is the navigation term. Zone 0 is centered on the Greenwich meridian. Zones west of it are marked +1, +2, and so on; those to the east, −1, −2, and so on. Zone 12 surrounds the 180° meridian. The

number of a zone (with its sign) added algebraically to the civil time gives the corresponding Greenwich civil time.

*Advanced Time.* Advanced time is the technical designation of daylight-saving time, summer time, and others. It is not a different kind of time but only a different clock setting; it is still standard time. Advanced time used in a certain zone is the normal standard time of the zone immediately to the east. For example, clocks running on Eastern daylight-saving time are actually keeping 60th-meridian or Atlantic normal standard time. "Double summer time" in England causes the clocks to read 30th-meridian-east standard time (Eastern European time). Advanced time is more popular in cities than in rural communities. There is little advantage, if any, in advanced time for low latitudes or for high latitudes. It is unpopular on the farm, in the country in general, and in all scientific work. It should never be used in any records or work of scientific nature.

**International Date Line.** Since time moves, so to speak, westward around the earth, the effect is that the longitude of places where the local time is, say, 5 hr., increases westward continually; hence the 5-hr. (or any other) line may be thought of as moving around the globe. Consider the 0-hr. line. To the west of the longitude where local time is 0 hr., are the remains of the old day, whereas to the east of the 0-hr. line are early hours of the new day. Obviously, somewhere on the other side of the earth there must be a place where the date is changed abruptly. This place of change of date is the *date line* or international date line, an imaginary line in the Pacific Ocean, following the 180° meridian over much of its extent. At stations east of the date line the calendar day is one day earlier than at points to the west of the date line. As a person travels eastward, crossing the date line, his watch remains the same, but the date changes suddenly to one day earlier, causing him to repeat a day. As a person travels westward across the date line, the date changes suddenly to one day later, causing the traveler to omit a calendar day. In going over this critical line at sea, the practice is to change the calendar day at night, as if passing over it at midnight. *See also* CALENDAR; CLOCKS AND WATCHES; ELECTRONIC CIRCUITS (*Electric Oscillators*); OBSERVATORIES (*Work of Government Observatories*); SEASONS; SPACE AND TIME. H. S. R.

**TIME AND MOTION STUDY.** *See* INDUSTRIAL TECHNIQUES (*Industrial Scientific Studies*).

**TIMGAD** [tɪmgæ′d], ancient city of Numidia, 23 mi. east of Batna, Algeria, known in ancient times as Thamugas or Thamugadi. It was founded in A.D. 100 by Trajan through his legate L. Munatius Gallus and the III (Augusta) Legion, 14 Roman miles to the east of the site of the later camp of the III Legion at Lambaesis, at the meeting place of several routes. Controlling the outlets of the massive range of Mt. Aures to its south, it served as a settlement for veterans of the III and the XXX (Ulpia Victrix) Legion, a semifortress, a stabilizing influence upon neighboring native tribes, and a center of Roman culture in these remote parts. The founding is recorded in contemporary inscriptions on Trajan's Arch. The late date of the establishment precluded the city from mention in Classical authors; but its name appears in the official road-lists of the empire, and for a short space in Procopius' account of Justinian's wars. The local inscriptions yield fuller information.

Trajan's colony covered about thirty acres, sufficient for a population of about two thousand persons, but subsequent prosperity, aided by imperial favor, induced a considerable expansion. The life of the town lasted until its devastation in the Berber revolt of A.D. 534, after which it was restored with a strong castle, probably as part of Justinian's reorganization of the province; its history ends with the Arab invasion in A.D. 647. French excavations, beginning in 1881, have revealed the plan of both Trajan's small settlement, showing the typical rectangular form of a Roman camp, and the outlying quarters subsequently added and deviating from that street system; the house walls, made of small stones and mortar, now largely restored to a short distance above ground, contrast with the public buildings in cut stone, several of which it has proved possible to re-erect. The forum, temples, arches, theatre, library, churches, and mosaic pavements are characteristic of the time and civilization.

A. W. Van B.

**TIMISKAMING** [tɪmɪ′skəmɪŋ], a town in Timiskaming Co., Quebec, Canada, situated on the east bank of the Ottawa River, 41 mi. northeast of North Bay, Ontario, with which it is connected by the Ontario Provincial Highway 63. Quebec Provincial Highway 46 links the community with the mining region of northwestern Quebec. The Canadian Pacific Railway provides rail facilities. Timiskaming, which was incorporated in 1920, is important as the location of the Kipawa hydroelectric development. A large paper mill is the town's chief industry. The near-by Kipawa Lake region is noted as a hunting and fishing area. Pop. 1951, 2,787.

D. F. P.

**TIMIŞOARA** [ti′mishwɑ′rɑ] (Hung. Temesvár), a city in western Romania. The cultural and economic center of The Banat, it is located on the Béga Canal, about 250 mi. northwest of Bucharest and 25 mi. east of the Yugoslavian border. The city, founded in 1212 by Hungarians, was destroyed in 1242 by the Tatars. Captured by the Turks in 1552, it became the trade center of Turkish Hungary until 1716, when it was recovered by Prince Eugene of Savoy. Austria held it until, through the Treaty of Trianon, it went to Romania in 1921. Among the many churches within the city are the Roman Catholic and Greek Orthodox cathedrals, as well as several synagogues. It is the seat of a Roman Catholic and Romanian bishop. The city contains high schools, advanced trade schools, and a bank founded in 1906. Grains and the timber carried on the Béga Canal from the slopes of the Banat Mountains are the chief elements in the active trade of Timişoara. Its industries produce flour, tobacco, textiles, leather goods, metal wares, chemical goods, soap, and silk. Pop. (off. est. 1948) 111,987.

S. A.

**TIMMINS,** a town in Cochrane District, Ontario, Canada, situated on the banks of the Mattagami River, about 350 air mi. and 460 road mi. northwest of Toronto, on the Ontario Northland Railway. The town was named for Noah Timmins, one of the founders of the Hollinger Mines, who founded it in 1911. Timmins was incorporated in 1912. Its site was ideal; a dry sandy plain between the mine and the river, on which it was expected that five thousand people would make their homes. To house more than five times that number, the town has expanded into lower land to the north. It is the trade center for the Porcupine Gold Belt, a mining region covering several townships. Several large lumber mills are located along the Mattagami River near Timmins. Pop. 1951, 27,743.

D. F. P.

**TIMON OF ATHENS** [tai′mən] (c. 1605-1606), the most confused and incoherent play in the Shakespearean canon. The original text in the Folio is a medley of misprints, misnomers, inconsistencies, and contradictions, and all

the labors of modern editors have barely sufficed to make the action intelligible. The best explanation is that Shakespeare, perhaps shortly after completing *Lear,* began a play about the famous misanthrope Timon. Shakespeare had read of him in Plutarch's *Life of Antony* and possibly in a Latin translation of Lucian's *Dialogues,* used as a textbook in many English grammar schools. Timon, it seems, was a rich Athenian who squandered his fortune in gifts to false friends, and later, reduced to poverty, experienced from them the basest ingratitude. He then turned misanthrope and cursed mankind. While digging in the fields he discovered a buried treasure, and was once more besieged by flatterers, whom he drove off with threats and blows.

Shakespeare seems to have been engaged in the dramatization of this story when he was interrupted by the demand for a new play at court that resulted in the composition of *Macbeth.* He apparently left his unfinished manuscript in the hands of his fellow-actors, and some time after his departure to Stratford they turned it over to a hack-writer to finish and equip with spectacle and musical effects for a performance at Blackfriars. The elaborate stage directions show that the Folio text was printed from an official playbook, but there is no record of a performance; if there ever was one, it probably ended in failure. There is some reason to believe that this playbook was sent to the printers of the Folio to fill what threatened to be a gap in that volume, so that it is only by chance, as it were, that the play has come down to us. It would have been a pity if it had been lost, for it contains some magnificent poetry, particularly in Timon's invectives against mankind. Yet the theme is essentially undramatic, and it is quite possible that Shakespeare himself recognized this and never returned to his unfinished fragment of a play.

T. M. P.

**TIMOR** [ti′mɔr; timɔ′r], the largest and easternmost of the Lesser Sunda Islands, in the Malay Archipelago, between Sawoe Sea on the west and Timor Sea on the east, about 400 mi. north of Australia. The eastern half of the island, together with the small exclave of Okusi Ambeno on the north coast of western Timor, belongs to Portugal, while the western part of the island, together with Flores, Soembawa, Soemba, Alor, Roti, the Sawoe Islands, and several lesser islands, forms the residency of Timor and dependencies in the Lesser Sunda Islands Province of the Republic of Indonesia. The residency has an area of 24,449 sq. mi. and in 1955 had an estimated population of 2,000,000; its capital is at Koepang, located on Timor. Portuguese Timor, the capital of which is at Dili, has a total area of 7,330 sq. mi., with a population (1950) of 442,378.

Timor itself is about 300 mi. long and 65 mi. at its widest point, covering an area of 13,094 sq. mi., with a population of about 1,200,000. The island is traversed by a series of parallel mountain chains, somewhat higher in the eastern portion, where they rise to about 7,000 ft. Volcanic activity is confined to mud geysers. The rivers are short and unimportant, of little use for irrigation and too swift for navigation. Prairies predominate on Timor and much of the land is sterile, but corn, rice, coffee, tea, sugar, cotton, and fruits are cultivated where the soil is rich. Native agriculture, however, is extremely primitive. Forest growth is scanty, but sandalwood, eucalyptus, rosewood, teak, and bamboo are found in sufficient quantity for export. There are two seasons, that of the southeast monsoon, from May to November, in which practically no rain falls, and that of the northwest monsoon during the rest of the year, when violent rainstorms prevail. The hottest regions are the coastal plains, where the average temperature is 80°-100° F. The population of the island includes Malay, Polynesian, and Papuan elements, divided loosely into the Belonese in the center and east, and the Timorese in the west. There are also some Chinese, Arabs, and Europeans.

**History.** The Dutch first came to Timor in 1613, but found, as elsewhere, powerful rivals in the Portuguese, who had already obtained power in the island in the course of the sixteenth century. Koepang was seized by the Dutch in 1618, but the Portuguese influence in the western portion of the island was not finally overcome until 1749. During the British occupation of Java (1811-1815), the Dutch portion of Timor also surrendered to England, but it was restored to the Netherlands after the fall of Napoleon. Agreements settling boundary disputes between the Dutch and Portuguese were concluded in 1859, 1893, 1898, and finally in 1914. During World War II Timor was occupied by the Japanese, and in December 1949 the residency of Timor was made a part of the newly formed United States of Indonesia, which in 1950 became the Republic of Indonesia. The eastern half of the island, together with the exclave of Okusi Ambeno, remained a Portuguese colony.

C. W. D.

**TIMOR SEA,** a shallow, tropical body of water separating Timor Island in the Malay Archipelago from the northwestern part of the continent of Australia. The Timor Sea connects the Arafura Sea on the northeast with the Indian Ocean on the southwest. R. G. B.

**TIMOTE.** *See* INDIAN TRIBES, SOUTH AMERICAN (*Other Linguistic Groups and Tribes*).

**TIMOTHY, ST.,** disciple and companion of St. Paul, mentioned a score of times in the New Testament, was born probably at Lystra in Lycaonia of a Greek father and a Jewish mother, Eunice. Converted, circumcised, and entrusted with difficult and confidential missions by Paul, he shared Paul's first captivity at Rome, accompanied him on his last missionary journey, and was placed by him over the Church of Ephesus. The authenticity of the two Epistles to Timothy was first seriously questioned in the nineteenth century, chiefly on grounds of internal evidence, but it has been defended by numerous Catholic and Protestant scholars, who date the letters in the period between A.D. 65 and 70.

W. C.

**TIMOTHY GRASS,** *Phleum pratense,* an important grass cultivated for hay in the eastern United States and Canada, also called "cat's-tail" and "herd's-grass." It is a native of Europe and Asia but is widely naturalized in North America. It is a strong-growing perennial with many long, flat leaves and a cattail-like flower spike from 1 to 8 in. long, at the end of smooth erect stems from 2 to 5 ft. high. Timothy grass will not stand pasturing and is primarily grown for hay. It thrives and is commonly planted with other crops such as red or alsike clover. The plant is open pollinated and seed is put on the market in a mixture of types; it is seldom available in a true selection. The price of seed is usually low in comparison with other grasses. About 10 lb. of seed with 4 to 6 lb. of other grasses is the usual amount sown per acre. It is believed that about 1720 seed was brought to Maryland from Europe by Timothy Hanson, whose name has been commonly given to this valuable hay and forage plant in America. C. K. H.

**TIMUCUA.** *See* INDIAN TRIBES, NORTH AMERICAN (*Southeast*).

**TIMURLANE.** *See* TAMERLANE.

**TIN,** symbol Sn (Latin, *stannum*), atomic number 50, at. wt. 118.7, density ($\alpha$-tin 5.75, $\beta$-tin 7.31), m.p. 231.89° C., b.p. 2,260°C. Tin has been found in Egyptian tombs; and deposits of the Tin Islands of Cornwall, the Cassiterides, supplied the ancient world. The fall of Carthage ended the tin trade, so that coins minted after this date contain increasing quantities of lead to replace the tin. Bronze, an alloy of copper and tin, was also known in ancient times.

**Forms.** Tin exists in three allotropic forms, alpha, beta, and gamma.

$$\underset{\text{(gray)}}{\alpha\text{Sn}} \overset{18^\circ}{\rightleftarrows} \underset{\text{(white)}}{\beta\text{Sn}} \overset{161^\circ}{\rightleftarrows} \gamma\text{Sn} \overset{232^\circ}{\rightleftarrows} \text{Sn (liquid)}$$

Gray tin has a cubic, diamond lattice; white tin, hexagonal; and gamma tin, rhombic. The transition from white to gray tin is slow at the transition temperature but at —50° C. it occurs within a few days; the transition is accompanied by an increase in volume, so that the product is powdered. This effect, known as tin pest, makes the use of tin inadvisable where subzero temperatures exist. For instance, the tin pipes of an organ in Leningrad, then known as St. Petersburg, crumbled to a gray powder during the cold winter of 1867-1868.

**Properties and Uses.** Tin is a white, soft, silvery metal of low tensile strength. At room temperature, it is brittle; but at about 100°C., it becomes malleable and may be rolled into tin foil and extended into pipes. Tin cry is a crackling sound emitted when a bar of tin is bent. Tin is used chiefly as tin plate, manufactured by dipping sheets of low-carbon steel into molten tin, or electroplating the sheet steel as it is passed through a bath. Ordinary pins are brass wire, coated with tin by displacement of the zinc in the wire by a tin salt. Tin plate, unlike galvanized zinc plate, does not give galvanic protection, since tin is higher in the electromotive series than iron. Forty per cent of the tin produced is used for tin plate and 22 per cent for tin-lead solder. Molten tin and lead are completely miscible and do not form compounds. Alloys of these two metals are differentiated as follows: 50 per cent tin is common solder; 33 1/3 per cent tin is plumber's solder; and 64 per cent tin is the eutectic, or alloy with lowest melting point (180° C.).

**Principal Compounds.** Tin forms stannous compounds with dilute or concentrated HCl, or dilute $HNO_3$; stannic compounds with hot concentrated sulphuric acid; and metastannic acid, $SnO_2 \cdot H_2O$, with concentrated nitric acid. With alkali hydroxides the tin dissolves to form stannites:

$$Sn + 2NaOH \rightarrow Na_2SnO_2 + H_2\uparrow.$$

Tin does not evolve hydrogen readily with acids because of high back electromotive force. Soluble stannic compounds are reduced to stannous by contact with tin.

*Stannous Oxide.* Stannous oxide, $SnO_2$, is prepared by heating stannous hydroxide, and burns in air to form a hydroxide. It is amphoteric, forming stannites and stannous salts with alkalies and acids, respectively. Stannous halides are prepared by reducing stannic halides with tin, or by dissolving metal in the halogen acid. Stannous hydroxide, $Sn(OH)_2$, is amphoteric. Like a base, it reacts with HCl to form $SnCl_2$ plus water; like an acid ($H_2SnO_2$), it reacts with KOH to form potassium stannite, $K_2SnO_2$.

*Metastannic Acid.* Metastannic acid, $H_2SnO_3$ (alpha stannic acid or stannic acid), is hydrated stannic oxide, $SnO_2 \cdot H_2O$. It is formed as a gelatinous white precipitate by the action:

$$SnCl_4 + 4NH_4OH \rightarrow 4NH_4Cl + H_2SnO_3 + H_2O.$$

Metastannic acid, upon heating, forms $SnO_2$, losing water. The sodium salt, sodium metastannate, $Na_2SnO_3 \cdot 3H_2O$, is a mordant and fire-retarding agent for cotton goods. The fabric is washed with the metastannate, then treated with ammonium sulphate; the ammonium stannate, so formed, hydrolyzes to stannic acid, which remains in the cloth and may lose the water to form stannic oxide.

*Stannic Chloride.* Stannic chloride is a heavy, colorless, fuming liquid, boiling at 114.1° C. It is prepared by heating tin in an excess of chlorine; in fact, the recovery of tin from waste tin plate depends upon this reaction, or upon a newer process using NaOH to form sodium stannite. Stannic chloride pentahydrate, $SnCl_4 \cdot 5H_2O$, is a mordant in dyeing, since it hydrolyzes on the cloth to produce colloidal, $Sn(OH)_4$. Other important tin compounds include ammonium chlorostannate $(NH_4)SnCl_6$, a mordant for cotton; and stannic sulphide, $SnS_2$, mosaic gold or gilt pigment.

**Analysis.** The oxide, $SnO_2$, has a crystal lattice like the mineral rutile. Fused with alkalies it forms the stannates, e.g., $Na_2SnO_3$, which are soluble in water; addition of acid precipitates $\beta$ stannic acid. This probably differs from meta or $\alpha$ stannic acid in its physical state. Hydrogen sulphide precipitates brown stannous sulphide, SnS, and yellow stannic sulphide, $SnS_2$, from dilute hydrochloric acid. In analytical chemistry, stannous and stannic sulphides are dissolved in yellow ammonium sulphide; both form the thiostannate $SnS_3^{-3}$, the stannous sulphide being oxidized by the polysulphide.

H. N. A.

**TINAMOU** [tɪ′nəmu], any one of a number of species of primitive New World birds that form a very distinct order in many ways intermediate between the ratites (ostriches and their allies) and all other existing birds. They are found from southern Mexico to Patagonia. Their size ranges from that of a small quail to that of a large domestic fowl. In general appearance they resemble the wholly unrelated partridges, although tinamou may at once be known from these by their thin bill, small head, and slender neck. Their plumage is generally a combination of browns and grays, often barred with black. Their eggs are remarkable, with the shells looking like polished metal or glazed porcelain and presenting such colors as yellow, green, blue, pink, and orange. These birds are easily snared, and many are exported from the Argentine to the markets of the United States, where they sell as South American partridge. H. G. De.

**TINIAN** [tiniɑ′n], one of the Mariana Islands between Guam and Saipan, located in the Pacific Ocean south of Japan and east of the Philippines at 15° N. lat., 145° E. long. The island belonged to Spain until 1899, when it was sold to Germany along with the rest of the Marianas, except Guam. Tinian was occupied by the Japanese during World War I and was retained as part of the Japanese Mandate, until its occupation by American forces in July 1944, during World War II. Tinian, because of its area of 50 sq. mi., its strategic geographical location on the southern approaches to Japan, and its rather level topography, was, like Guam and Saipan, an ideal site for basing very heavy bombers of the United States Strategic Air Force. It served as an important B-29 base for attacks on Japan during the last year of the war.

R. G. B.

**TINNEVELLY.** *See* TIRUNELVELI.

**TÍNOS** or **TENOS** [ti′nɔs, ti′nɒs], one of the marginal islands of the Greek Cyclades group in the Aegean Sea. It consists of two mountain systems with deeply serrated ridges, and the slopes, laid out in terraces, are covered with fields and vineyards. Tínos, the capital, occupies a picturesque site

on an open bay on the south coast. In the town is the Church of the Evangelistria, built over a well where, in 1823, a miraculous icon of the Virgin was found. The icon is kept in the church and was supposedly painted by St. Luke. Thousands of pilgrims gather at the shrine every year. The island has an area of 79 sq. mi. Pop. 1951 (town), 2,758; (island), 10,191. S. Van V.

**TINTAGEL** [tɪntæ′jəl], a village and parish in Cornwall, England, about 207 mi. southwest of London. It was once known as Bocyny, and according to an old legend King Arthur was born in the castle whose ruins stand on Tintagel Head, 300 ft. above sea level. In 1933 the ruins of a Celtic monastery were uncovered, indicating the site's use from very early times. The village is listed in Domesday Survey, and it had a charter which was surrendered to Charles II. A new charter was obtained in 1685. In 1784 the rector, as mayor of Tintagel, was the only voter qualified to send a representative to Parliament. In 1835 the village was made part of the county parliamentary district. Tourists create much of its business. Pop. approx. 1,300. A. W.

**TINTERN ABBEY** [tɪ′ntərn], a beautiful ruin of a former Cistercian abbey founded in 1131 by Walter de Clare, 5 mi. north of Chepstow in Monmouthshire, England. Located in a broad meadow on the right bank of the River Wye, the abbey forms one of the most romantic ruins in England. The church, which is the principal feature of the present ruins, dates from 1270-1325. The building, 228 ft. long, is an excellent example of Geometrical Gothic; the roof, tower, and north wall of the nave are missing. A notable attraction is the great east window, 64 ft. high, with lovely tracery, but other carved decorations are likewise beautiful. The little village of Tintern is near by. The locality is especially associated with William Wordsworth, who in 1798 composed one of his most famous poems a few miles above Tintern Abbey, on the Wye. R. Ne.

**TINTORETTO (JACOPO ROBUSTI)** [tɪntoræ′to, yɑ′kopo robu′sti] (1518-1594), Venetian painter, was born in Venice in the autumn of 1518, the son of Battista Robusti, a dyer, from whose occupation he earned the nickname Il Tintoretto ("the little dyer"). He probably was first influenced by Titian, but the tradition that he was expelled from the studio when his precocious drawings aroused the older painter's jealousy seems unlikely. He may have worked with Bonifazio Veronese, Andrea Schiavone, and Parmigianino. The most important factors in his development were certainly such aspects of the Venetian tradition as the idyllic landscape painting of Giorgione and the didactic narrative art of Carpaccio. Subsequently he was affected by Michelangelo's energetic treatment of the nude. He secured small casts of the Medici tomb sculptures from which he made many drawings, as well as from the antique and from small clay models drastically foreshortened. Whether or not he placed in his studio, as it has been claimed, the motto, "The drawing of Michelangelo (combined with) the color of Titian," the special qualities of both masters were merged, by 1548, in a more personal style in the *Miracle of St. Mark* (Venice, Academy), the first painting to attract the admiration of his contemporaries. The lengthy series of mural paintings for the Scuola di San Rocco, which was executed between 1559 and 1584, is very useful in the study of the gradual evolution of his style. Tintoretto's technique, although derived from the typical Venetian feeling for color pattern achieved through multiple glazes, became a most sensitive instrument for the presentation of his complex emotional and intellectual interpretation of religious history. The surface of the canvas, in places covered with a thick impasto, elsewhere lightly glazed or even bare, is the material counterpart of the tempestuous and excited design. In his treatment of space Tintoretto's characteristic schemes, based on deep and oblique diagonals, foreshadowed the Baroque solutions of the seventeenth century. The slender proportions of his figures, related to Florentine mannerism through Michelangelo, disturbed the

*MIRACLE OF SAINT MARK*

FROM THE PAINTING BY TINTORETTO

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abstract and ample dignity of the Titianesque canon, even as his introduction of startling and often commonplace genre details into the most solemn incidents indicated his desire to interpret religious history in a more modern manner. In this he showed his awareness of the direction taken by the Catholic Counter-Reformation. His mythological and allegorical paintings for the Doge's Palace presented an active renewal of the Venetian insistence upon the sensuous pleasures of luxurious living. In 1590, when over seventy, he completed his vast *Paradise* for the Doge's Palace, the commission for which he had won in competition with several younger artists. In size, conception, and execution it challenges comparison with Michelangelo's *Last Judgment,* to which in a sense it is the Venetian equivalent. Tintoretto died in Venice May 31, 1594. G. H. H.

**TINY TIM,** the crippled, youngest child of Bob Cratchit in Charles Dickens' *A Christmas Carol* (1843), who helps to create the spirit of Christmas and to soften the heart of Scrooge. DeL. F.

**TIPPERARY** [tɪpərɛ′ərɪ] or Tiobraid Arann, the name of a town and county in Munster in the south central part of the Republic of Ireland.

**The Town.** The town of Tipperary is situated in the Golden Vale, near the Galty Mountains, in County Tipperary, 110 mi. southwest of Dublin. The town's name was derived from the Ara River, whose source is near by. Tipperary is an important dairy-farming center, and its industries include milk processing, glove making, knitting, and linoleum manufacture. Of interest is the gatehouse, which is all that remains of the friary erected by Henry III in the thirteenth century. Pop. 1951, 5,148.

**The County.** Tipperary, the only inland county of Munster, has an area of 1,662 sq. mi., of which 214 are water. It is bounded by the counties of Galway and Offaly on the north, Laoghis and Kilkenny on the east, Waterford and Cork on the south, and Limerick and Clare on the west. The county is divided into the North Riding and South Riding. In the central part, Tipperary is level, and the soil is very fertile, especially in the district known as the Golden Vale. The borders, however, are hilly. The Knockmealdown Mountains, with a highest elevation of 2,609 ft., extend for 15 mi. between Tipperary and Waterford; the Galty Mountains, with a highest elevation of 3,018 ft., are in the southwest; Slievenaman Mountain, 2,364 ft. high, is in the southeast; and the Keeper and Devil's Bit ranges extend for 18 mi. in a northeast-southwest direction along the southern part of the North Riding. The prevailing rock is carboniferous limestone. The principal rivers are the Shannon and the Suir. The town of Cashel was the ancient capital of the kings of Munster. On the Rock of Cashel, a limestone formation 300 ft. high, are the ruins of a thirteenth-century cathedral, and of Cormac's Chapel, the latest example of Irish Romanesque architecture, a style which was not used after the Anglo-Norman invasion in the twelfth century. Clonmel, the county town, was the native town of the novelist Laurence Sterne. Pop. 1951, 133,313. S. Van V.

**TIPTON,** a city in central Indiana, the county seat of Tipton Co., located 35 mi. north of Indianapolis. The tomatoes, corn, and beans raised in the vicinity are processed in Tipton, whose industrial output also includes sheet metal, poultry and hog supplies, piston rings, furniture, and chemicals. A mayor and council administers the community. Pop. 1950, 5,633.

**TIRANË** or **TIRANA** [tirɑ′nə, tirɑ′nɑ], the capital of Albania, located 18 mi. from the Adriatic Sea near the center of the country. The surrounding region is cultivated for farm products as well as olive and almond groves. Founded in 1600 by a Turkish general, the city has since 1920 been rapidly expanded and modernized, losing much of its original Turkish appearance. The government buildings, the

WIDE WORLD PHOTOS

*Government buildings in Tiranë, capital of Albania*

palace of the former King Zog, and a number of legations are in the city. Tirane has civil and military hospitals and several schools. Italy occupied the city in 1939, and it remained under Axis control until the withdrawal of German forces in November 1944. The city has a flour mill, brick factories, cement-block works, and printing establishments. It is connected by roads to most of the important cities of the country and by railroad with the coastal city of Durrës. Pop. 1945, 59,887.

**TIRE,** a band of solid rubber or inflated rubber and fabric casing, sometimes a rim of steel. The whole is placed around the rim of a wheel to absorb shock, reduce abrasive wear, and transfer through traction, the power of a vehicle to the surface of the road.

The pneumatic tire envelops and absorbs small objects in its path without raising the center of a wheel. A vehicle, equipped with metal tires, is lifted when it passes over any object; the degree of shock experienced by a vehicle with solid rubber tires encountering the same object is determined by the elasticity of the rubber. The use of a pneumatic tire reduces the shock to a minimum, for the compressed air within the tire is displaced for the instant, and the combined elasticity of the air and the rubber covering of the tire absorbs the shock.

Although pneumatic tires provide traction for the wheels and transmit the horsepower of a vehicle's engine to the road surface, it is equally important that the tires dissipate the energy of the vehicle when the brakes are applied. The tread, the part of the pneumatic tire that contacts the road, has engraved in it patterns that grip the road to provide traction and guard against straight-line or side skidding.

**History.** *Solid Tires and Early Air-filled Models.* The first crude forerunner of the pneumatic tire, as we know it today, was the invention of Robert William Thomson, an Englishman. In 1845, a patent was issued to Thomson for "the application of elastic bearings round the tire of wheels of carriages, rendering their motion easier and diminishing the noise they make while in motion." To accomplish this, he proposed using "a hollow belt composed of India rubber . . . and inflated with air, whereby the wheels will at every

part of their revolution present a cushion of air to the ground, or rail, or track on which they run."

Thomson's "Aerial wheels" were large—five in. in diameter, when used on a brougham. Their size and relative noiselessness attracted much attention. Thomson's solid rubber tires, which were as much as five in. thick, proved more popular, and the "Aerial Wheels" were forgotten. Solid rubber tires, built according to patents dating back to 1871, were introduced by the leading English rubber manufacturers in 1884. Their appeal lay in their quiet-running characteristics and traction. That same year, one company applied for a patent for a tire with a hollow center or with a spongy, porous center to give added resilience.

The growing popularity of the bicycle in the second half of the 19th century increased, on the one hand, the demand for solid rubber tires and, on the other, revived interest in air-filled casings. The first pneumatic tire for bicycles was developed by John Boyd Dunlop, a veterinary surgeon of Belfast, for his son's tricycle. The tire was a rubber and linen tube wrapped with tape and laced upon the rim of the tricycle wheel. It worked so well that Dr. Dunlop obtained patents for the tire in 1888 and 1889. On these patents, the Dunlop Pneumatic Tyre Company, Ltd., was founded.

The problem of how to fix a tire to the rim of a wheel, securely and reliably, was partially solved by Charles Kingston Welch. In 1890, he suggested that a tire be built with thick edges in its canvas cover or outer layer. In these edges, an endless wire could be sewed, forming a circle of wire that would fit tightly in the well of a metal rim, specifically grooved to hold it in place. The wearing surface or tread was vulcanized to the tire in a separate operation and cemented to the wire-fastened tire body.

William E. Bartlett devised the method of fastening tires to metal rims most often used on bicycles and early automobiles. In 1890 an English patent was issued for his "clincher" fastening. Instead of containing wire to hold the tire on the rim, Bartlett's casing had beaded edges that curved under the flanges of the rim. The pressure of air in the inner tube held the tire on the rim.

A parallel development was the single tube or "hose pipe" tire which was built by wrapping layers of rubber-impregnated fabric on a stick or mandrel. After the stick had been removed, the tire was cured and its ends cemented together. This type was widely used on bicycles and on the earliest American cars equipped with pneumatic tires. The single tube remained in favor on bicycles, light carriages, and sulkies. In both the United States and Europe, however, the clincher tire was preferred for automobiles. In 1903, tire manufacturers agreed to standardize the contours of tires and rims, so that they would be interchangeable.

The early clincher tire was round in cross section. In 1904, the first straight-side pneumatic tires were manufactured. They had a wire cable in the bead or edge. When the tire was clamped to the wheel by bolted rim flanges, the inextensible wire kept it from expanding and loosening. Improvements were made so that it was less liable to pinch the inner tube.

Early in the twentieth century, several improvements were made in tires. One that was generally adopted by manufacturers originated with John E. Palmer, an Englishman. He introduced a kind of fabric which proved superior to the cross-weave canvas or linen then in use. According to Palmer's design, the fabric was made of cotton threads all laid in the same direction and embedded in rubber. The fabric was cut into strips of desired width, with the ends slit on a bias angle. A strip was wound on the core of a tire-building drum, and another strip was wound so that its threads would run in the opposite direction. This method of tire building, manufacturers found, provided the maximum strength of the tire cord body in all directions subject to stress.

The first non-skid tread—NON-SKID was engraved in the tire tread, at an angle to the center line of the tire—was introduced by Firestone in 1908. Diagonal bars, grooves, and knobs became the principal types of tread design. These designs, engraved on the tire during vulcanization, make available hundreds of small edges of tread rubber which grip the surface of the road, providing traction. They also catch surface water on wet pavements, permitting the tread rubber to roll on a relatively dry surface.

During the early days of the automobile industry, tire manufacturers endeavored to develop longer-wearing tires; by 1910, they could guarantee 4,000 mi. The tire size became larger, as more plies of fabric were added to increase tire strength—as many as 14 plies were not uncommon. With a large number of plies, however, the tire became heavier and less resilient.

*Balloon Tires.* The balloon tire was commercially introduced by The Firestone Tire & Rubber Company in 1922. Its development was dependent on adhesion of the body plies and tread and on a greater resilience in the cord body, which were obtained by dipping the cord fabric in a rubber solution before it was embedded in solid rubber. This process is commonly referred to as gum dipping. With its lower air pressure, but greater air volume, the balloon tire had a lower bursting stress to withstand. The casing could be made lighter, four plies of resilient cord taking the place of eight or more stiff plies. The balloon tire had a larger diameter and sidewall height than the earlier high-pressure tires. Its thinner walls deflected to a greater degree under shocks of the road, and the wider tread rolled more smoothly over bumps and obstructions. Vibration and road shock were absorbed by the resiliently encased cushions of air, and motorists could drive at higher speeds with less threat of punctures, because the soft tires yielded to obstructions that would have pierced a taut casing. The balloon tire in general use today has a nonskid tread. Manufacturers work to develop better designs to improve traction and guard against the danger of skids.

Balloon tires have proven to be more flexible and easier to handle even in the factories. Manufacturers who had been shaping tires on drums fitted with steel cores, could build them now on flat drums and the tire could be formed by air pressure into doughnut shape before vulcanization, equalizing the stresses on the cords. By 1928, the tire industry had switched completely to the flat-band method of manufacturing on cylindrical drums.

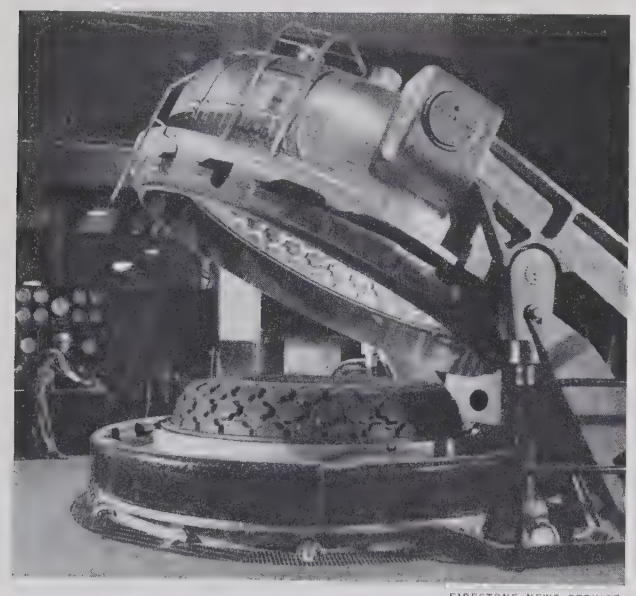
Among the major tire developments in the past 25 years have been: tire cords made of synthetic fabrics, such as rayon, introduced in 1933, and nylon; tire cords of rubber-covered steel wire for truck and bus tires; synthetic rubbers, which have increased tread mileage and air retention; the super-balloon tire, which operates at an even lower pressure than the balloon tire. The diameter of rims used on cars and trucks have decreased, allowing a lower center of gravity so that the vehicle holds the road and handles better. The stronger cord fabrics often outlast the tire body. As a result, "retreading," the application of new tread rubber to a used tire body at temperatures low enough not to damage the tire body, has been developed.

Special tires have been created for airplanes. They are strong, light-weight, and resist the tremendous shock of

landing impact. They must roll safely along runways at high speeds without the treads tearing off. Jet airplanes, for example, land at speeds up to 250 mph.

In 1954, tubeless tires became available for automobiles and, in 1955, they were adopted for heavy trucks. As its name implies, the tubeless tire substitutes a lining of rubber for a separate inner tube. The lining is made of synthetic rubbers because of their good properties of air retention. Since the liner is an integral part of the tire, the tire itself becomes the container for the air under pressure. The tubeless tire is claimed to provide greater protection against punctures and blowouts and longer mileage. Heat is an enemy of tire life. The tubeless tire, being lighter, runs at lower temperatures than a tire and tube. The tubeless truck tire is considerably lighter than its tubed counterpart, allowing more cargo to be carried without increasing overall weight.

**Manufacture.** The strength of a tire and its ability to throw off heat generated by high speeds are due largely to the kind and quality of fabric used in its construction. The tire body consists of several layers of nylon or rayon cord bonded together and overlaid with the tread. Fabric makes up about 12 per cent of the weight of a passenger car tire and 15 per cent of a truck tire's weight.



FIRESTONE NEWS SERVICE

*In the world's largest tire-vulcanizing machine green rubber is cured and tread and sidewall patterns impressed.*

Tire compounds are made of latex or synthetic rubber, sulphur, carbon black, oils, and other chemicals. They are used to impregnate cotton, rayon, or nylon cord to produce cord fabric plies, or, if extruded, to form the tread and sidewall rubber layers. The quantities of other materials used determine the special characteristics of the rubber, whether it will be, for example, a pliant sidewall rubber or a very tough, abrasion-resistant tread. The rubber used in impregnating the fabric is different from that in either sidewall or tread.

In the manufacture of tires, rubber is cut into pellets, then weighed with exact amounts of carbon black and pigments. A conveyor carries the rubber and other ingredients to a chute that leads into a Banbury mixer. Liquid chemicals are added. After thorough mixing, the batch is pelletized a second time. Sulphur, accelerators, and other powdered chemicals are weighed and conveyed with the rubber into another Banbury mixer.

The mixed or "compounded" batches of rubber are dropped into mills where the rubber is rolled into thick sheets which are cut off in strips. It is then ready to be made into the different parts of the tire.

Rubber stock is kneaded and heated on warming mills to make it more workable. Stock for use in treads and sidewalls are conveyed from the warming mills and fed into two opposing extrusion machines. Both stocks are extruded through one die, the tread stock through the central portion and the sidewall stock through the outer edges of the die, so that they are welded together as a single unit. After weighing and cooling, the extruded tread and sidewall rubber is cut to proper lengths ready for use in building the different sizes and types of tires.

Rayon and nylon cords are dipped in a special rubber liquid compound and dried. Calendering follows. Rubber from warming mills is automatically fed into the rolls of the calendering machine, which presses it onto both sides and in between the cords. The calendered fabric is rolled into cloth liners to prevent sticking and is cut "on the bias"—diagonally across the cords. The pieces are turned, laid end to end, and spliced into a continuous strip. The result is a strip of material cut to a specific width, with all the cords running in a diagonal direction.

In the preparation of rubber-covered steel wire cords, a number of strands of steel wire are brought together from reels and guided through a die, where rubber stock is squeezed around and between the separate strands. The rubber-covered wire is wound around a ring several times in a bead-building machine; the number of revolutions is determined by the size and type of tire being made. The bead is then covered with a strip of fabric called a "reinforce," which ties the bead into the tire, giving the latter extra strength and stability. The bead acts as an anchor to hold the tire on the rim.

To make a four-ply tire, the beads are first put in position. Then a bias-cut ply, with its cord angle running in one diagonal direction, is placed on the drum of the assembly machine. A second ply is placed over the first; its cord angle runs in the opposite diagonal direction. These two plies produce equal strength in all directions. The beads are locked into place; the plies are turned up and over the beads and secured. The third and fourth plies are added, and extra strips of fabric are placed around the bead areas to prevent chafing at the rim.

The tread and sidewall unit is then put in position. Rotating wheels under pressure "stitch" and compact the plies and tread, forcing air from between the different layers. After this, the third and fourth plies are turned down and under the beads and stitched in place; the drum is collapsed, and the barrel-shaped cylinder of rubber and fabric is removed.

The tire which is green or uncured, is next subjected to the forming and vulcanizing process. When placed in a curing mold, which looks much like a giant waffle iron, it is a soft, pliable object. In the mold, internal pressure forces a curing bladder into the tire, so that the tire becomes doughnut shaped. Live steam is injected into the bladder and around the mold causing the mold to heat, softening the rubber, and forcing it into the nonskid pattern of the tire mold. In the tightly sealed mold, heat causes a chemical change, vulcanization, which fuses the many parts of the tire into an integral unit. After a prescribed length of time,

which depends on the tire size, the finished tire is removed from the mold.

Forming and curing are separate operations in manufacturing some tires, particularly very large ones for certain trucks and earthmovers. Hydraulic presses force curing bags into the tires to shape them. Then the shaped, but uncured, tires are placed in molds for vulcanization.

In the finishing room the tire is cleaned, polished, and checked on a sensitive balancing machine before shipment to a motor vehicle manufacturer or a retail tire outlet. *See also* RUBBER.

F. B. L.

**TIRESIAS** or **TEIRESIAS** [tairi′siəs], in Greek legend, a renowned soothsayer of Thebes, blind from youth because, as one legend has it, he had seen the goddess Athena bathing. According to another version, he was blinded by Hera for disparaging her sex when, as the only mortal who had lived as both man and woman, he was chosen to decide which experienced the greater pleasure in love. This tale is the theme of an opera by Francis Poulenc and Guillaume Apollinaire and of a ballet by Constant Lambert. Tiresias played a prominent part in Theban legend, uttering prophecies to Oedipus and, in the war of the Seven Against Thebes, to the sons of Oedipus. He retained his prophetic powers after death, and Circe sent Odysseus to consult him in the underworld concerning the return to Ithaca. *See also* SEVEN AGAINST THEBES.

**TIRO, MARCUS TULLIUS.** *See* SHORTHAND.

**TIROL (TYROL)** [tiro′l; tɪ′rəl; tɪro′l], a province of western Austria lying almost wholly within the Alps. It is composed of two disconnected portions, separated as a result of the cession of South Tirol to Italy in 1919. The western and larger part of the province is bounded by Germany (Bavaria) on the north, the province of Salzburg on the east and southeast, Italy (Trentino-Alto Adige) on the south, Switzerland on the southwest, and the province of Vorarlberg on the west. East Tirol, with an area of 780 sq. mi., is bounded by the province of Salzburg on the north, the province of Carinthia on the east, and otherwise by the Italian Tirol. The total area of Austrian Tirol is 4,884 sq. mi.

Many Alpine ranges lie within the province, and among the highest peaks are the Wildspitze (12,382 ft.) and Hochfeiler (11,555 ft.). The Achensee and the Plansee are the largest lakes. The principal rivers are the Inn, which flows from southwest to northeast across the province, the Lech, and the Isel. The Ötzthal, longest lateral valley of the Inn, is broad and fertile in its lower portion.

Dairying is the leading industry, and the tourist business is a major source of income. Lead, iron, lumber, salt, and coal are produced. The main railway line traverses the length of the province from St. Anton am Arlberg on the west to Kitzbühel on the east. The principal cities include Innsbruck, the capital, Landeck, Kufstein, Hall, Schwaz, and Rattenberg. Lienz is the major town of East Tirol.

Tirol was divided between the early Roman provinces of Rhaetia and Noricum. The feudal rulers were the counts of Tirol and the Babenbergs. In 1363 the Hapsburg family inherited the province. The Tirolese have always enjoyed a large degree of autonomy. Of several Tirolese emperors of Austria, perhaps the most distinguished was Maximilian I (1459-1519), who married Mary, daughter of Charles the Bold of Burgundy, thereby adding her inheritance of the Netherlands to Austria's possessions. In the era of the merchant princes, the cities of the Tirol were brisk centers of trade and manufacture. During the wars of the French Revolution the Tirolese, led by Andreas Hőfer, offered spirited resistance to Napoleon and his allies, the Bavarians. Pop. 1951, 427,465.

EWING GALLOWAY

*Cortina d'Ampezzo, an Alpine resort in the Italian Tirol*

**South Tirol.** The Treaty of St. Germain in 1919 gave Italy not only the Italian-speaking district of Trentino, but also a large part of the Tirol, with over 200,000 inhabitants of purely German speech and origin. Between the two World Wars efforts were made to Italianize the population, but many emigrated to Austria. By the peace treaty signed in Paris on Dec. 12, 1946, Italy retained South Tirol but agreed to grant broad powers of autonomy to the German-speaking element.

Italian Tirol, occupying northern Trentino-Alto Adige, an autonomous region, adjoins Switzerland on the west and Austria on the north and northeast. It is more than 5,000 sq. mi. in area and is the most fertile part of the Tirol. Roughly triangular, its southernmost point extends to the northern shore of Lake Garda. The Rhaetian Alps sweep across it, and its principal rivers are the Adige and the Isarco. There are many lakes. The largest towns are Merano, Bolzano, and Trento. In recent years Cortina d'Ampezzo has achieved international fame as a ski center.

**TIRPITZ, ALFRED VON** [tɪ′rpɪts] (1849-1930), German statesman and admiral, was born at Küstrin, in Brandenburg, Mar. 19, 1849. He entered the Prussian navy in 1865 and rose through the ranks to Lord High Admiral of the Imperial Fleet in 1911. In 1897 Tirpitz became Secretary of State and thereafter the builder of German sea power. During the ten years preceding World War I, Tirpitz led an unflagging campaign for a strong navy and by 1914 had made the German navy the second largest in the world. He planned and carried out unrestricted submarine warfare against Great Britain, a policy which was abandoned only after the sinking of the *Lusitania* and the subsequent strained relations between the United States and Germany. Disapproving of Germany's promise to abandon unrestricted submarine warfare, he resigned on Mar. 17, 1916. Tirpitz died at Ebenhausen, Mar. 6, 1930. R. H. L.

**TIRSO DE MOLINA** [ti′rso the moli′nɑ] (c. 1583-1648), Spanish dramatist, whose real name was Fray Gabriel Téllez, was born in Madrid. He was educated at the University of Alcalá and entered the Mercenarian order in 1601. In 1625, possibly because of certain allusions to contemporaries in his plays, the Council of Castile recom-

mended that he be sent to a provincial monastery and forbidden to write further "profane comedies containing bad incentives and examples." In spite of his consequent banishment to Trujillo, in 1632 he was appointed official historian of the order, finally completing a long-projected *Historia general de la orden* in 1639. He died in the monastery at Soria, March 12, 1648.

Like other playwrights of his time, Tirso followed the generic precepts established for the Spanish drama by Lope de Vega, whose methods he defended in his novel *Los Cigarrales de Toledo* (c .1621) ("The River Gardens of Toledo"). Yet in the eighty plays remaining from his original three or four hundred, Tirso displays an original tendency to satire and attack and a superb sense of characterization all his own. Perhaps his best-known plays are *El Burlador de Sevilla* ("The Libertine of Seville"), which first defined the figure of Don Juan Tenorio; *El Condenado por desconfiado* ("The Man Damned for Little Faith"), based on the religious doctrines of the Catholic Reformation; *El Vergonzoso en palacio* ("The Timid Youth at Court"); and *Don Gil de las calzas verdes* ("Sir Gil of the Green Breeches"), which contains one of his characteristic types, an aggressive woman, who in man's disguise goes in search of her faithless lover. Thus, like most of his contemporaries, Tirso's dramatic production ranged from melodramatic intrigue to exposition of religious doctrine, from social comedy to tragicomedy of character, and his subject matter embraced the whole range of knowledge and interest of the time. S. G.

**TIRUNELVELI** or **TINNEVELLY** [tɪ′runɛ′lvɛli; tɪnavɛ′li], a large town of extreme southern India, in the state of Madras, located near the left bank of the Tambravurni River about 70 mi. south of Madurai. Four miles from Tirunelveli, across the river, is the town of Palamcottan, which is noted as the site of the early missionary work of St. Francis Xavier during the sixteenth century. Tirunelveli District, of which the town is the administrative center, has the highest percentage of followers of the Christian faith of any district of southern India, and Palamcottan is an important mission headquarters. The most renowned building in Tirunelveli is the Hindu Temple of Siva, an excellent example of Dravidian architecture. The relatively poor agricultural region, for which Tirunelveli serves as a processing and distribution center, specializes in cotton, millet, oil seeds, and low-grade sugar cane. There is also trade in timber from Shencottah (Travancore). Pop. 1951, 73,476.

**TIRYNS** [tɪ′rɪnz], a prehistoric fortified city in the northeastern Peloponnesos in Greece, about a mile from the coast at the head of the Gulf of Argolis, and about halfway between Argos and Návplion. It stands on a low rocky hill in the plain, but the hill when first inhabited may have been a peninsula or even an island. It is primarily interesting for its tremendous fortifications and its well-preserved palace remains, both of Mycenaean times.

The remains indicate that the site was inhabited before 3000 B.C., and flourished in the Early Helladic Period (third millennium B.C.). The next period of great prosperity reflected in the ruins is the Mycenaean Age (Late Helladic III, fourteenth-twelfth centuries B.C.). The city was populated to some extent from that period until well into Classical times, sending soldiers to the allied army opposing Persia at Plataea in 479; it was substantially destroyed by Argos in 458 B.C. In Roman times it was a deserted ruin.

The site was first excavated by Heinrich Schliemann and Wilhelm Dörpfeld in 1886. Subsequently it was investigated for the German Archaeological Institute by Dörpfeld and Georg Karo in 1905, and by Karo and others later, particularly in 1926-1929. These researches have provided information on two notable building complexes, one Early Helladic and the other Mycenaean.

Of the Early Helladic period, apart from oval, apsidal, and rectangular houses, Dörpfeld and Karo found the foundations of an enormous circular structure on the top of the hill. It was some 93 feet in diameter, built of mud brick on foundations of stone arranged in two concentric circles, buttressed outside by piers. Tiles found among the debris indicate that the structure was roofed, but the method of supporting the great span of the roof has not been established. In any case, the building is the period's most monumental structure of which remains are known.

The chief interest of the site centers on the Mycenaean remains. There are ruins of houses outside the walls, but the most important remains are those of the fortifications and the palace. The central parts of the fortifications were first built in the fifteenth century B.C., and rebuilt in the fourteenth; in the thirteenth century a reconstruction and expansion gave them their present form. They enclose an area some 1,000 feet long and 300 wide, divided into two main parts: the upper citadel with the palace, and the lower citadel on the northern extension of the hill, providing protection for people and flocks in time of siege. A small terrace between is called the middle citadel.

The walls are famous for their impressive dimensions. In places they are still 26 feet thick and 25 high; elsewhere they reached 57 feet in thickness and an unknown height. They are built of enormous blocks of stone, originally set in mud mortar. The main entrance is elaborately contrived along the east side. A ramp clinging below the wall ascends to an outer gate which gives access to a passage lined on each side by walls, leading to the lower citadel on the right and the upper on the left. The latter passage is blocked by a massive gate beyond which the passage continues to an entrance court, on one side of which was a colonnade. On the west side of the upper citadel is a postern made up of a narrow flight of steps curving through the thickness of the wall. Other posterns more plainly devised pierce the walls of the lower citadel. Beside the entrance court on the east the wall attains unusual thickness, and contains within itself a corridor and a series of seven chambers, one of which was a cistern, the others being for dry storage. A similar corridor and row of five storage chambers are built into the south bastion, approached from the palace yard by narrow steps. The west wall of the upper citadel also contains storage chambers.

The palace is better preserved in ground plan than any other princely mansion of its period on the mainland. It consists of a collection of megara (rectangular halls with porches), most of them with their own courtyards and miscellaneous rooms, courts, and corridors. From the entrance court a monumental gate gives access to the palace yard. The gate has the "H" plan with columns between the ends of the walls on each front, which is characteristic of Hellenic architecture. A smaller gate joins the yard to the colonnaded court of the chief megaron. This megaron consisted of a porch with two columns, a vestibule, and a main hall with a hearth and a roof supported by four columns. West of the megaron was a complex of small rooms and corridors, including a bath, the floor of which consisted of a single slab of stone cut to provide drainage for the water. A corridor led behind the megaron to another smaller and simpler megaron facing on a small court; this secluded unit may

have been the private, as opposed to the state, residence of the lord. North of this were other rooms, some resembling megara, in a complex array. A passage led from this section directly to the large gate leading to the entrance court. Fragments of fresco show that the palace was decorated in a modified version of Minoan style.

The terrace behind the palace, known as the middle citadel, may have contained independent dwellings or garden areas. It was separated from the lower citadel by a massive wall comparable to the outer fortifications. R. L. S.

**TISCHENDORF, LOBEGOTT FRIEDRICH KONSTANTIN VON** [tɪ'shəndɔrf] (1815-1874), German textual critic of the New Testament, was born at Lengenfield, Saxony, Jan. 18, 1815. He was professor at Leipzig from 1845 until his death. Von Tischendorf was an assiduous searcher for manuscripts of the Bible in the libraries and monasteries of Europe and the Near East, and in 1843 obtained at the Convent of St. Catherine on Mt. Sinai one of the two oldest vellum codices of the Greek Bible. This manuscript, consisting of 43 leaves, dated from the fourth Christian century and was named the Codex Sinaiticus. It is now in the British Museum. In 1859 on a second trip to the East he obtained the rest of the manuscript, which was presented to the tsar. Von Tischendorf edited many Greek and Latin manuscripts of the Bible and published twenty editions of the Greek New Testament, the most famous of which is the *Octava critica maior* (1869-1872). He died in Leipzig on Dec. 7, 1874. B. M. M.

**TISDALE,** a town in Saskatchewan, Canada, 125 mi. northeast of Saskatoon, located in a farming region. Tisdale was named after Frederick W. Tisdale, who was a Canadian Pacific Railway station agent when the townsite was founded. It has grain elevators. Pop. 1951, 2,141. L. G. R.

**TISSUE,** in biology, a group of cells and their intercellular substances which are united in the performance of a particular function. The body is a co-ordinated composite of five types of tissues: (1) epithelia; (2) connective tissue; (3) muscular tissue; (4) nervous tissue; and (5) blood and lymph.

An epithelium is a cell-rich, avascular tissue which lines a surface. Epithelia may consist of a single layer (simple), such as lines the blood vessels and peritoneum, or they may be many layered (stratified), as in the skin and mouth cavity. Epithelia have many diversified functions and modifications. Paramount among these is the formation of glands: all glands are formed principally by epithelia or epithelioid tissue.

Connective tissues are characterized by few cells and an abundance of intercellular substances. This group of tissues is the largest in the body: its primary function is the support of other tissues. Areolar tissue, tendons, ligaments, aponeuroses, cartilage, and bones are examples of connective tissues.

Muscular tissue consists essentially of cells whose property of contractility has become predominant. Three types of muscular tissue are found in the body; skeletal muscles (voluntary), cardiac (involuntary), and smooth (involuntary).

Nervous tissue is composed of nerve cells and their fibers and supporting cells. The predominant function of this tissue is to carry impulses (irritability and conductivity).

Blood and lymph comprise a group of tissues composed of cells and fluid intercellular substance. The cellular elements of vascular tissues comprise the red and white blood corpuscles, and the interstitial substance, the plasma. W. Mo.

**TISZA, COUNT ISTVÁN** [tɪ'sɒ] (1861-1918), Hungarian statesman, was born at Budapest, Apr. 22, 1861, the youngest son of Kálmán Tisza, who was prime minister of Hungary from 1875 to 1890. Tisza entered parliament in 1866, and until his death was among the most prominent figures in Hungary. Tisza's chief interest was in maintaining the pre-eminence of Hungary in the Dual Monarchy by continuing Magyar national supremacy in Hungary and by supporting the alliance with Germany to weaken the position of Austria. He was prime minister from 1903 to 1905, and again in 1913. He opposed the Austrian policy toward Serbia in July 1914, fearing that a war would destroy the balance in Hungary's favor. After the outbreak of World War I he marshaled all support for its prosecution, but refused to consider reforms, such as the extension of the suffrage, which were demanded on behalf of the non-Magyar nationalities. Tisza's influence over Emperor Francis Joseph was great, but after the latter's death he was dismissed by the young Emperor Charles in May 1917. After commanding a regiment of Hussars at the front, he returned to Budapest in October 1918, seeking to weld all parties together to obtain favorable peace terms. He was assassinated by revolutionary soldiers on Oct. 31, 1918. H. M. M.

**TISZA** [tɪ'sɒ], one of the important tributaries of the Danube River, about 800 mi. long. It rises in the Carpathian Mountains in the western Ukraine and, after crossing and recrossing the boundaries between the Ukraine and Romania and Hungary as it flows in a generally westerly direction, it turns southward across the great plain of Hungary and northeast Yugoslavia until, as the Tisa, it joins the Danube about 30 mi. above Belgrade. Notable tributaries are the Szamos and the Maros (Mureşul). The only important city on the river is Szeged, the second largest in Hungary. In spite of river-regularization works, large areas along the Tisza are still liable to floods. The middle valley is one of the richest wheat-growing areas of Hungary. N. Cas.

**TITANIC,** an English ocean liner lost in an extraordinary marine catastrophe. Just before midnight on Apr. 14, 1912, the White Star liner *Titanic* on its maiden voyage from Southampton to New York, while still almost 1,300 mi. from its destination, struck an iceberg and sank, leaving 1,490 dead. Casualties were particularly heavy among the crew, only 24 per cent surviving. None of the ship's band or of the engine crew was saved. Of the 534 women and children aboard 70 per cent survived; of the 1,667 men only 20 per cent. Among those lost were the ship's captain; the president of the Grand Trunk Railway, Charles H. Hayes; the vice-president of the Pennsylvania Railroad, J. B. Thayer, Jr.; John Jacob Astor, Jr.; Benjamin Guggenheim; George D. Widener; and Isador Straus, whose wife refused rescue.

When the tragedy occurred the sea was unusually calm and the night was clear and cold. Although the captain had received warning of icebergs ahead he had decided to follow the prevailing practice of relying on a sharp lookout rather than reducing speed. For this he was severely criticized by a London court of enquiry headed by Lord Mersey. Also castigated was the captain of the Leyland liner *Californian* for refusing prompt aid to the stricken vessel although his ship was less than ten miles away when distress signals were reported. This most tragic of ship disasters to the largest vessel then afloat (46,328 tons gross), occurring on the ocean's most heavily travelled route, brought investigations on both sides of the Atlantic and resulted in the tightening of the marine laws of the United States and England in matters relating to equipment and practices for the promotion of safety at sea. W. M. W.

**TITANIUM** [taite′niəm], symbol Ti, atomic number 22, at. wt. 47.90, density 4.5, m.p. 1,800° C., b.p. over 3,000° C. Titanium, named after the Titans of Greek mythology, is the first member of Group IV-A of the periodic table, followed by zirconium and hafnium. The members of the A and B families of Group IV resemble one another more closely than those in any other group; and titanium closely resembles silicon and zirconium. Titanium is a transition element, having an atom which contains two completed shells of electrons (2, 8), a third incomplete shell of 10, and a fourth or valence shell of 2. Titanium behaves as a metal, losing its two outermost electrons and forming compounds in which it is bivalent ($Ti^{++}$), but these are unimportant. Trivalent ($Ti^{+++}$) and quadrivalent compounds ($Ti^{++++}$) are more important, but the most characteristic compounds are the titanates in which titanium serves as a nonmetal, giving $TiO_3^{--}$ ions.

**Occurrence.** Titanium is the ninth element in abundance, making up more than 0.6 per cent of the crust of the earth. It is several times as abundant as many of the elements which are much better known and much more important. The chemistry of titanium has developed slowly, and it is still regarded as a rare element because so little is known about it and its compounds. It is found as rutile, $TiO_2$ (analogous to $CO_2$ $SiO_2$, $ZrO_2$), in titanates such as ilmenite, $FeTiO_3$ (like $FeCO_3$), and in varying amounts in silicates, tantalates, and many other mineral products; it is almost always present, at least in traces, in sand, clay, soil, mineral waters, and plant and animal tissue.

**Uses.** Titanium is obtained as a dark-gray paramagnetic powder or as a fused compact metal resembling polished steel. It is usually brittle, but when pure and properly treated it is strong and ductile and capable of being forged, drawn, and fabricated. It is stable in the air, but when heated to 610° C. it takes fire and burns with dazzling brilliancy. It alloys readily with other metals. The most important alloy is ferrotitanium, very useful in the steel industry both as a deoxidizer and in making alloy steels. It contributes to the production of hard steel, and aids in increasing resistance to shock and corrosion. Titanium also alloys with copper and the bronzes, a notable development being the construction of the combustion chamber of jet aircraft engines by use of an alloy of nickel, chromium, and titanium.

**Principal Compounds.** Titanium compounds in commerce are not numerous. The trichloride, $TiCl_3$ forms unstable violet crystals, useful in solution as a reducing agent in analytical chemistry and for removing stains in the laundry. The tetrachloride, $TiCl_4$, a colorless liquid, forms dense white fumes in moist air; it is used in manufacturing iridescent glass and artificial pearls. With ammonia it is used in skywriting. Titanium dioxide, $TiO_2$, is manufactured from ilmenite. It is a white powder, insoluble and infusible, becoming dark when heated. It is widely used in the manufacture of enamels, glazes, linoleum, rayon, plastics, white rubber, paper, leather, shoe creams, and face powders. Its most important use is in paints, both as straight $TiO_2$ and as composite pigments. Its advantages are high covering-power, lightness, permanence, nonpoisonous nature, and ease of mixing with oil. B. S. H.

**TITANS** [tai′tənz], in Greek mythology, the children of Uranus (Heaven) and Gaea (Earth). They were twelve in number, six sons (Oceanus, Coeus, Creus, Hyperion, Iapetus, and Cronus) and six daughters (Theia, Rhea, Themis, Mnemosyne, Phoebe, and Tethys). The more important of these were Hyperion and Theia, the parents of Helios, Selene, and Eos; Oceanus and Tethys, the parents of river gods and ocean nymphs; and particularly Cronus and Rhea, the parents of Hestia, Demeter, Hera, Pluto, Poseidon, and Zeus. The Cyclopes and the Hecatonchires were also the offspring of Uranus and Gaea. When these were imprisoned in Tartarus by Uranus, Gaea appealed to the Titans; Cronus mutilated Uranus with a sickle, and from the latter's blood came the Furies and the Giants. In the war with the Olympian gods, all the Titans except Oceanus supported Cronus, but they were defeated and consigned to Tartarus. The Titans were ancient figures, belonging to a past already remote to the early Greeks, and several of the names seem to be of foreign origin. As a group, the Titans have been explained as personifications of earthquakes and volcanic eruptions or as representations of the wild forces of Nature; they are overcome by the Olympian deities who stand for peace and order. The name "Titan" was given also to sons of the original Titans, such as Atlas, Prometheus, and Hēlios. *See also* CRONUS; URANUS. G. E. D.

**TITCHENER, EDWARD BRADFORD** (1867-1927), American psychologist, was born at Chichester, England, Jan. 11, 1867. He was educated at Brasenose College, Oxford. Studying further under Prof. Wilhelm Wundt at Leipzig, he received his Ph.D. in 1892. Titchener devoted his life to the development of experimental psychology from the point of view of structuralism. From the systematic point of view, he was a follower of Wundt, although he went far beyond Wundt in his insistence on pure psychology and the analysis of immediate experience by means of introspective analysis into elements and attributes. In 1904 Titchener began a series of spring meetings for invited psychologists which continued until his death in 1927. This informal group constituted the nucelus of the famous Society of Experimental Psychologists which was organized in 1928. He died in Ithaca, N. Y., Aug. 3, 1927. A. W. S.

**TITHE** [tai′th] (O.E. *teotha,* a tenth), generally defined as the tenth part of fruits and profits justly acquired, owed to God in recognition of his supreme dominion, and paid to the ministers of religion. It is an institution of undetermined antiquity, common to the Israelitic and many pagan religions. Adopted in principle by the Christian Church from apostolic times, and subjected eventually to formal legislation (Synods of Tours, 567, and Macon, 585), the institution was later enforced by the civil authority (late eighth century Capitularies of Charlemagne), recognized in pre-Norman England and sanctioned by English statute law (Westminster, 1285). It has continued in modern times in the cases of the established Church of England and the Roman Catholic Church—notably in Austria and Hungary—but elsewhere it has been generally replaced, with changed political and social conditions, by other systems of voluntary support of the clergy. N. J. T.

**TITHONUS** [tɪtho′nəs], in Greek mythology, son of Laomedon of Troy and brother of Priam. He was beloved by Eos, goddess of the dawn, and became by her the father of Memnon. She procured for him from the gods the gift of immortality but forgot to ask for eternal youth; as a result, Tithonus became a shriveled old man and eventually turned into a grasshopper. G. E. D.

**TITI** [titi′], any one of several species of small, squirrel-like monkeys, *Callicebus,* related to the saimiris. Titis inhabit Brazil and the Amazon basin. They have small eyes and a

small head which is depressed and not elongated. The fur is thick, consisting of long, fine, wavy hairs, beautiful in texture with well blended, modest colors. The tail, usually longer than the body, is covered with bushy hair. The nails are relatively long and compressed. Titis are diurnal. In captivity they are retiring and inactive. R. T. H.

**TITIAN (TIZIANO VECELLI)** [tɪ′shən, titsyɑ′no vetshɛ′lli] (c. 1477-1576), Italian painter, was born in Pieve di Cadore (Veneto) sometime between 1477 and 1488. His first recorded work, frescoes, now indistinct, on the façade of the Fondaco dei Tedeschi, Venice, were done (1508) in such close association with Giorgione, then the most gifted and original painter in Venice, that the nature of Titian's early style has always been a subject of controversy. His frescoes illustrating the *Miracles of St. Anthony* (Scuola del Santo, Padua), done the year after Giorgione's death, 1511, being also considerably damaged by time, do not completely resolve the enigma, despite their evident novelty of invention and mastery of light and form. The first well-preserved work of Titian's, which is also dated indisputably, is the large altarpiece of the *Assumption of the Virgin* (1516-1518, Frari, Venice), which is obviously the mature production of a great artist. A few preserved drawings (Louvre, Paris; British Museum, Victoria and Albert Museum, London) betray the careful study that preceded the painting, but the light quill lines and the blunt chalk strokes served Titian only as a means of visualizing his concepts, rather than as a chart from which he was to work in the usual Italian manner. From the first, he saw the picture in terms of paint; and, as he worked, the different densities of pigment, which an oil medium permits, were deftly and sensitively exploited to create a glowing pattern of colored textures and to evoke a vision of beautiful human forms, not so much revealed by light, as moving in a world of softened lights and transparent shadows. This became the theme of Titian's art, whether he was showing a Venetian family introduced to the Virgin by its patron saints in a lofty loggia (*Pesaro Madonna,* 1519-1526, Frari) or showing a meadow full of sportive loves at the base of a statue of Venus (*Worship of Venus,* Prado, Madrid). Throughout his long, active life, he continued to develop his power of expression through light, shadow, and color, passing, from decade to decade, through the exquisitely balanced textures and golden light of the *Venus of Urbino* (1537, Uffizi, Florence), the rich, dark warmth of the *Portrait of Paul III* (1543, Naples), the opalescent transparencies of the *Europa* (1561, Gardner Museum, Boston) to the grey dissolving shapes of the *Pietà* (1576, Academy, Venice). His emotional power equalled his technical skill. He was capable of understanding and presenting the human tenderness of a *Holy Family* (Florence, London, Madrid, Venice, etc.), the tragedy of an *Entombment* (1559, Louvre; Prado), or the mystic fervor of the *Trinity* (1553, Prado) which satisfied the religious fanaticism of the Emperor Charles V; but his genius was best liberated when he was treating a fresh, lyrical theme drawn from ancient literature (*Sacred and Profane Love,* Borghese Gallery, Rome; *Venus Anadyomene,* 1523, Bridgewater House, London; *Bacchus and Ariadne,* 1523, National Gallery, London; *Danaë,* 1546, Naples), or in the portrayal of the personal quality and natural human dignity of a distinguished man or a beautiful woman (*Tommaso Mosti,* c. 1524, Uffizi; *Isabella of Portugal,* c. 1545, Prado). His enormous success as a portraitist, which brought him commissions from dukes, kings, and princes of the Church, was certainly due to the fact that he was able to paint each individual sitter's ideal of himself. The portraits are clearly always likenesses (*Cristoforo Madruzzo,* 1542; *Jacpop Strada,* 1566, Vienna) and equally clearly give us Titian's estimate of the character of the personage represented (*Young Englishman,* Pitti, Florence; *Cardinal Granvella,* 1548, Kansas City, Mo.) but the subject's physique and his character are always ennobled by Titian's recognition of his ideal potentialities and by the beauty of Titian's art.

Titian's success brought him considerable wealth. He was a host both to such intimates as Pietro Aretino, as well as to distinguished state visitors, including Henry III of France. With the exception of the year 1548, spent at the imperial court at Augsburg, where he painted many portraits of celebrities, and another year, 1545-1546, spent at the papal court of Paul III in Rome, Titian resolutely refused all offers, however lucrative, to leave the relative freedom of Venice. But he was not thereby parochial in his outlook on contemporary art and culture. In brief visits to near-by Mantua and Urbino, he saw paintings by Raphael and Correggio; casts, engravings, and drawings made him familiar with the sculpture and painting of Michelangelo even before he visited Rome and Florence. Collections of antiquities, like that of Cardinal Grimani, came under his eye at Venice, giving him an ac-

PHOTOGRAPH BY ALINARI

FROM A PAINTING BY TITIAN

*SACRED AND PROFANE LOVE*

quaintance with that idealization of the human form so inspiring to the artists of the Italian Renaissance. Usually Titian's indebtedness to the antique or to his great contemporaries is so transmuted by his pictorial handling of a borrowed motif that it almost eludes detection, but occasionally, as in the astonishing foreshortening of the *Sacrifice of Isaac* or the *David and Goliath* (1543, San Spirito, Venice), he seems to challenge comparison, lest his preference for a more fluent and natural mode of expression be misconstrued as an incapacity to work in "the grand manner." Titian set the tone for the next two centuries of Venetian painting, and he so enlarged the aesthetic potentialities of the art of painting that he is the spiritual father of later schools as well. He died in Venice on Aug. 27, 1576. R. W. K.

**TITICACA** [titikɑ'kɑ], a lake, the highest navigable body of water in the world, on the Andean Altiplano at an elevation of 12,644 ft. in eastern South America. Its dimensions, a length of about 95 mi. and a width of 35 mi., give it the distinction of being the largest lake on that continent. It is divided into two sections by the peninsulas of Copacabana on the west, and Huata or Achacachi on the east. The narrow strait of Tiquina connects the northern part, Chucuito, and the southern part, Winaymarca. The Peruvian-Bolivian boundary transverses the northern section from southwest to northeast. The northern lake, many parts of which are over 600 ft. deep, contains fresh water; the southern lake is shallower and slightly brackish. The average temperature of the lake water is 51° F. The Rio Desaguadero drains southward from the lake. To the north of the peninsula of Copacabana lie the famous islands of Titicaca and Coati, known respectively as the islands of the sun and the moon. Many ruins of the Inca and pre-Inca Tiahuanaco civilization have been found on both islands. South of the peninsulas are many small islands. On the east side of the lake, in Bolivian territory, are the towns of Achacachi and Puerto Acosta. Steamers between Guaqui in Bolivia and Puno in Peru connect at these towns with trains to and from La Paz, Bolivia, and Mollendo, Peru. Natives with boats of reeds or lumber imported from the forest of northeastern Bolivia carry on a fishing industry, selling their surplus catches in La Paz. P. E. J.

*Native craft on Lake Titicaca*

RICHARD B. HOIT FROM CUSHING

**TITLARK,** any of small larklike birds of the family Motacillidae inhabiting all parts of the world. The American titlark, *Anthus rubescens,* is very generally distributed over North America breeding in the Rocky Mountain states northward to Alaska and wintering in the Gulf states, Mexico, and Central America. It is 6½ in. long, the upper parts olive-brown, the under parts pinkish-buff streaked with brown. It confines itself to open country, showing a marked preference for wet fields and bogs. Its food consists of worms, insects, and seeds of various kinds. The grayish speckled eggs, four to six, are laid in a grass nest on the ground. C. R. Eb.

**TITMOUSE,** any one of numerous species of small to very small (4-7 in.) songbirds of the family Paridae. They are allied to the nuthatches and in some ways, despite their very different appearance, even more closely to the crows and jays. They are widely distributed in temperate and tropical regions of both the Old and New Worlds, excepting South America. The most typical titmice, exemplified by the chickadee, have the crown and throat black, the remaining upper parts gray, blue, or olive green, the remaining under parts yellow or white, but there are many variations on this pattern; some species are conspicuously crested. They are frequent dooryard visitors not easily frightened by man. H. G. De.

**TITO.** *See* Broz, Josip.

**TITRATION.** *See* Analytical Chemistry.

**TITUS (TITUS FLAVIUS SABINUS VESPASIANUS)** [tai'təs] (c. A.D. 40-81), Roman emperor, son of Vespasian, was born in Rome, Dec. 30, 40 or 41. He served in Germany and Britain and commanded a Roman legion in Vespasian's campaign against the Jews, directing the campaign in Judea in 69; he took Jerusalem, Sept. 8, 70, after a long siege, and on his return to Rome he was rewarded with the title of Caesar and was given a part in the government. Soon afterward he and his father celebrated triumphs recorded by the Arch of Titus. Titus was not popular at first, partly because of his relations with Berenice, sister of Herod Agrippa, who came and lived in his palace, but on succeeding his father as emperor (A.D. 79) he established a record as a humane and progressive ruler and became the idol of the Roman people. He ended prosecutions for treason and became *pontifex maximus* to avoid shedding blood. He completed the Colosseum begun by his father and built new public baths and other institutions for the public benefit. He also visited Pompeii when it was destroyed but returned to Rome to assist those made homeless by a three-day fire. There was little war during his brief reign, the only fighting being in Britain. Titus died at Reate, Sept. 13, 81. T. R. H.

**TITUSVILLE,** a city in Crawford Co., in northwestern Pennsylvania, situated on the north bank of Oil Creek, 15 mi. north of Oil City. It is an industrial community in a natural gas and oil district. Titusville was settled in 1796 by Samuel Kerr and Jonathan Titus and named for the latter. It became a borough in 1847 and received its first city charter in 1866. Another charter was granted in 1889 and the commission form of government in operation in 1950 was adopted in 1914. Under the direction of Col. Edwin L. Drake in 1859, the first artesian oil well drilled in the United States struck oil, thus starting the Pennsylvania oil industry. In 1872 nat-

ural gas was discovered, and the pioneer development of the Pennsylvania gas fields began at Titusville. The museum in Drake Well Memorial Park contains parts of the original well equipment. The New York Central and the Pennsylvania railroads and American Airlines planes supply transportation. In addition to the production and refining of petroleum and the manufacture of its by-products, other industries produce oil-well supplies, steel products, gas and steam engines, cutlery, and explosives. Agricultural products of the area include milk, buckwheat, and potatoes. Po. 1950, 8,923.

**TITYUS** [tɪ′tiəs], in Greek mythology, a giant, the son of Gaea. Having attempted to assault Leto, he was slain by the arrows of Apollo and Artemis, or by a thunderbolt of Zeus, and cast into Tartarus. There he lay outstretched on the ground, with two vultures forever devouring his liver, which grew again as rapidly as it was consumed.
G. E. D.

**TIVOLI** [ti′voli], a town of the region of Latium, in central Italy, about 20 mi. east-northeast of Rome. It is an episcopal see, noted as the site of the Renaissance palace, the Villa d'Este. The town has light industries, and a hydroelectric plant is nearby. Tivoli was badly damaged by bombs during World War II. Pop. 1936, 16,886.

In ancient times the town was known as Tibur. It is situated at a point where the Anio River, seeking an outlet toward the volcanic plain, has worn a deep gorge into which it falls in impressive cascades. The river valley forms an important route connecting the Latin plain, and particularly Rome, with the interior of the peninsula and with the Adriatic coast; it was for this reason that Tibur, which controlled this route, the Via Valeria, and gave the name Via Tiburtina to its first stretch, attained its prominence. The original site of the town was determined by the erosion which had almost isolated a portion of the limestone rock, making a natural stronghold which dominated the Anio gorge.

In early times Tibur was a member of the Latin League, hostile to Rome; later (at the end of the fourth century B.C.) it became an ally. Early remains, mostly from the era of the Roman Republic, include portions of the city walls, two temples—one rectangular and one round—overlooking the inner gorge, and a deposit of clay ex-votos, testifying to the existence of a primitive sanctuary on the slopes of the outer gorge. There is also a huge rectangular architectural ensemble built upon massive substructures at a point below the town where the hillside slopes toward Rome; with this structure, as numerous inscriptions show, the cult of the local patron hero, Hercules, and eventually that of the Imperial House were associated. The early Imperial Period is represented by several buildings about the forum, and especially the office of weights and measures. The hillsides of the Tiburtine territory overlooking the river, and the gently-sloping declivities in the direction of the plain, attracted the Romans of all periods, who chose them for the sites of their villas. Tibur was particularly noted as a health resort; the ancient warm sulphur baths, 5 mi. west of the town, are the modern Acque Albule. Many eminent persons possessed country and suburban estates near Tibur; the poets, notably Horace and Catullus, knew and loved the region. Water from the Anio, or from the four great aqueducts which passed here on their way from the upper valley of the river to Rome, could be diverted for the use and amenities of the villas. Between the years 126 and 134 A.D. the Emperor Hadrian, himself a dilettante architect, acquired a pre-existing residence, situated some distance from the town on the lower slopes toward Rome, and, starting with the earlier nucleus, constructed a huge imperial residence, the surviving portions of which rank among the best-preserved and most extensive remains of Roman architecture.
A. W. Van B.

**TLAXCALA** [tlɑskɑ′lɑ], the name of the smallest state of the republic of Mexico and of its capital.

**The City.** Tlaxcala is situated in the central part of Mexico on the Atoyac River, 22 mi. north of the city of Puebla and 71 mi. east of Mexico City. In the sixteenth century, at the time of the Spanish Conquest, it was a place of considerable size and great importance, but it has declined steadily since then. Tlaxcala has little industry, although it is served by the Mexican Railway and is an outlet for the state's agricultural products. Among the most notable of the city's historic buildings is the church of San Francisco, built in 1521, which is claimed to be the oldest on the North American continent. Pop. 1950, 5,071.

**The State.** The state of Tlaxcala is bounded on the northeast, east, south, and southwest by Puebla, on the west by Mexico, and on the northwest by Hidalgo. Although its area of 1,555 sq. mi. is the smallest in the republic, it is one of the most densely settled. There are no large cities, but the state has many small farms which are efficiently cultivated. Tlaxcala forms a part of the central Mexican plateau and has an average altitude of about 7,000 ft. The terrain is hilly and in many places mountainous. In the thirteenth century this was the powerful native state of the Tlaxcalans, a Nahuatlan people who came from the region of Lake Texcoco and successfully opposed the Aztecs. When Hernando Cortés and his Spaniards invaded Mexico, the natives fought against him for a time; after Cortés defeated them, however, they joined with the conquerer to subdue the Aztecs. The state is predominantly agricultural, although it has some iron and silver mines and local handicraft industries. Its textile industry has also become important. Pop. 1950, 284,551.
S. G. I.

**TLEMCEN** [tlɛmsɛ′n], a city in Algeria, and capital of an *arrondissement* in the department of Oran, about 80 mi. southwest of the city of Oran. It is situated near the Moroccan border, on the north slope of the 2,500-ft. Lella Setta hills and at the border of the great depression to the west of the plain of Oujda and Taza Pass. It is an ancient city, rebuilt in the eleventh century by the Zenata dynasty, and was the capital of Maghreb in the Middle Ages. Tlemcen prospered in the fourteenth century under the Merenide dynasty but was taken by the Turks in 1554. It was attacked by the French in 1836 and finally taken by them in 1842. In its vicinity are prosperous cultivations of olives and vineyards. The town has many sites of interest, among which are the ancient ruins of Sidi bu Medin, the mosque of Jamaa el Kebir, built in A.D. 1136, the mosque of Halawi, the museum of antiquities, the Meshuar or citadel, and the Kessaria (the market of European merchants). The city is divided into four sections: the Jewish section in the southwest, the Moorish in the southeast, that of the merchants in the northeast, and the new town in the northwest. Tlemcen is noted for its fine cloth, carpets and shawl industries. In 1936 about two thirds of the population were natives. Pop. 1948, 51,372.
M. B. H.

**TNT.** *See* Explosives.

**TOADFISH,** *Opsanus tau,* a sculpinlike fish with a large flat head and huge mouth in the family Batrachoididae.

The ventral fins are located far forward on the throat in front of the pectoral fins. Glands in the naked skin secrete large quantities of slime. The toadfish lives in shoal water along the east coast of North America from Maine to Cuba. It hides among plants or in dens under stones awaiting its prey which includes a long list of invertebrate animals and small fishes. Toadfish attain a length of 15 in.; the male stands guard over the large, adhesive eggs which measure 5 mm. in diameter. They are laid in a single layer in holes under stones, in old cans, or even in old shoes on the bottom. Even after hatching, the young remain attached to the large yolk sac which still adheres to the bottom. The young break away when slightly over one-half inch in length. The toadfish burrows in mud in offshore areas during the winter. When handled, it makes loud croaking noises by contracting the air bladder. It is of no commercial value and some members of the family are poisonous. E. C. R.

**TOADFLAX,** the name commonly given to a large genus, *Linaria,* of herbaceous plants of the figwort family. Their flowers are showy and many-colored, with long spurs, and are borne in terminal clusters; their leaves are whorled or opposite. A few of these small, smooth herbs are widespread as weeds, while several are grown as garden ornamentals. More than 100 species are found widely grown throughout the north temperate regions. In North America seven species occur; the two most common are butter and eggs, *L. vulgaris,* and the blue toadflax, *L. canadensis.* The former, which bears showy orange- and yellow-colored flowers, has been naturalized from the Old World, while the latter is found across the continent and is recognizable by its delicate blue flowers bearing a threadlike spur. *See also* Butter and Eggs. M. G. W.

**TOADS,** a general term commonly applied to terrestrial, tailless amphibians which have squat bodies, short fore legs, and warty skins. Although the terms toad and frog are often used interchangeably, for many intermediate forms exist, the *Bufonidae* and closely related families are generally considered the true toads. They are found practically the world over, but not in Madagascar nor in some Pacific islands. Many species burrow in the earth and emerge at night to feed on insects. *Bufo americanus,* the common toad of North America, and *Bufo vulgaris,* of Europe, benefit farmers by eating injurious insects. Some toads live in ants' nests, in the tropics, and feed entirely on ants. Some forms have smooth skins and live in water. Most species lay their eggs in water, and the tadpoles become adults in a short time.

Many curious forms exist. The shell-headed toad of Cuba lives in a burrow, for which the horny surface of its head forms a perfect lid. One group, *Nectophrynoides,* of East Africa, is unique among the tailless amphibians, or Salientia, in that it gives birth to live young. Many species secrete an irritating or poisonous substance from their skins. However, contrary to popular belief, warts are not acquired from handling toads. A. Sv.

COURTESY OF THE AMERICAN MUSEUM OF NATURAL HISTORY

*AMERICAN TOAD, BUFO AMERICANUS*

**TOADSTOOL,** a common name given to various species of fungi having an umbrella-shaped cap. In popular usage, the name applies to any poisonous mushroom. The term also includes other fleshy mushrooms, such as the puffballs or morels. *See also* Fungi; Mushroom. J. C. Wis.

**TOASTER, ELECTRIC.** *See* Household Appliances, Electrical.

**TOBA.** *See* Indian Tribes, South American (*Principal Linguistic Families*).

**TOBACCO,** an herbaceous plant and its leaf, a member, *Nicotiana tabacum,* of the nightshade family. An annual, it is grown practically everywhere in the world. Its leaves, when dried or cured, are rolled into cigars, shredded for use in cigarettes and pipes, processed for chewing, or ground into snuff. The plant often reaches 6 ft. in height and is rich and luxuriant in appearance, although coarse and sticky to the touch. The unbranched stem bears leaves that attain a length of 1 to 2 ft. The plant produces pale pink or reddish trumpet-shaped flowers at the top. Tobacco seeds are minute and very numerous; one plant can produce more than 100,000 seeds.

THOMÉ—DR. LASCOFF

*Tobacco plant,* Nicotiana tabacum, *with detail of the flower showing pistil and stamens*

**Cultivation.** Although it is not an easy crop to cultivate, tobacco can be grown successfully in almost every cli-

mate and in many types of soil. However, tobacco tends to be greatly influenced by its environment, and the conditions under which it is grown have a considerable effect on its essential characteristics. The plant is very sensitive to soil, which determines texture, and to climate, affecting aroma. The successful cultivation of tobacco demands considerable knowledge and careful judgment on the part of the farmer, a great amount of hand labor, soils of above-average fertility, and an ample supply of fertilizer. In the principal tobacco-growing areas of the United States, seeds are first distributed in nursery beds (although hothouses or hotbeds are employed on tobacco farms in the North). Cloth is frequently used to protect the seedlings from the weather. When the young plants reach a height of 4 to 6 in., they are transplanted by machinery (except for very small crops) to the field. The field must be well rested, well nourished, particularly by potash, and well drained. Preventive measures must be taken by the farmer to control disease and the many insect pests that attack the plant. As soon as the flowers begin to bud, they are cut off, unless seeds are desired. Tobacco plants of the cigar-leaf variety are an exception, however, and are not pruned.

**Processing.** Tobacco crops are harvested four to six months after the original planting, at about the time when the leaves start to turn yellow; the most popular method of harvesting is to cut each leaf individually as it ripens, although in some instances the entire plant is cut at once. The leaves are then strung together for curing. Tobacco may be air-cured, flue-cured, or fire-cured. In the first process, the tobacco is either exposed to the sun or placed in open, ventilated barns and allowed to mature naturally. Tobacco that is to be flue-cured is hung in specially prepared, airtight barns which are heated by large pipes, or flues, that carry the warmth of exterior fires through the interior of the barn. This is a much more rapid process than the natural, air-curing method; most American tobacco is flue-cured. A third system is fire-curing. The tobacco is hung in barns that are airtight, and the smoke and heat rising from open fires on the floor of the barns cures the tobacco.

After curing, the leaves are subjected to moisture to prevent cracking or breaking, and are then sorted into the various standard grades based on size, color, quality, and similar criteria. The sorted tobacco is placed in cases, bales, or hogsheads and usually shipped to a central tobacco warehouse where it is eventually sold directly or auctioned to the highest bidder. Occasionally, tobacco sales take place on the tobacco farm itself. Marketed tobacco is repacked and allowed to age for a year or two before being manufactured into commercial forms.

**Manufacturing.** Although each variety and grade of tobacco is generally applicable to a particular use, manufacturers blend the various sorts of tobacco to obtain consistant, uniform types. In the United States, most tobacco goes into the manufacture of cigarettes, although considerable quantities are used in cigar-making. The manufacture of chewing tobacco and snuff is comparatively small. The tremendous growth in the popularity of cigarettes in the United States after World War I caused a corresponding decline in the production of cigars and other tobacco products, but the over-all consumption of tobacco increased.

The four greatest tobacco-growing countries are the United States, India, China, and the Soviet Union. However, in the latter three countries the bulk of the tobacco produced is consumed locally. Countries such as Cuba, Greece, and Turkey, which grow comparatively small amounts of tobacco, have much more important crops, since the tobacco grown in such places is in great demand throughout the world for use in cigars and cigarettes. The United States grows, manufactures, and consumes more tobacco than any other country in the world.

EWING GALLOWAY

*Burley tobacco in piles in the vast auction room of a Lexington, Kentucky, warehouse*

**Use.** The custom of smoking tobacco originated with the Indians of the Western Hemisphere, probably as early as A.D. 100. Tobacco was used at first principally in connection with religious rituals, but by the end of the fifteenth century tobacco smoking, although still retaining ceremonial characteristics, had become a common personal practice throughout most of the hemisphere. Europeans first learned of tobacco smoking when it was observed in Cuba by members of Columbus' crew in November 1492. Besides smoking tobacco, the Carib Indians also used finely powdered tobacco leaves as snuff; they inhaled the snuff through a hollow Y-shaped piece of cane by applying the forked ends to the nostrils and placing the other end close to the powdered tobacco. This instrument the natives called a "tobago" or "tobaca," which name, slightly altered, the Spaniards later applied to the tobacco plant and to its cured leaves.

The first substantial commercial cultivation of tobacco by Europeans was undertaken by the Spaniards, who laid out tobacco plantations in the West Indies in 1535 and shortly afterward grew it also in Spain. Tobacco first became popular in Europe chiefly for its supposed curative powers. It was frequently used in the form of poultices and sometimes taken as snuff. The use of snuff became the fashion in the court of Catherine de Médicis, Queen of France, who had tried it as a remedy about 1561 at the suggestion of her ambassador to Portugal. It was in honor of the ambassador Jean Nicot that the tobacco plant was later given the botanical name "Nicotiana." The Spaniards had a virtual monopoly of the European markets until 1575, when the Portuguese began to grow large quantities of tobacco. Later, Dutch colonists in the East Indies and English settlers in Virginia entered the competition for the European tobacco trade, and so rapid was the spread of tobacco smoking that by the early seventeenth century its use was almost world-wide. For a variety of reasons, however, tobacco was often looked upon with great disfavor by the rulers of the lands to which it was brought. Throughout the world royal prohibitions forbade the use of tobacco and threatened punishments that ranged up to the death penalty for a third offense. The last noteworthy royal edict against tobacco was published in Abyssinia near the end of the nineteenth century. Bans on smoking are

still enforced by certain religions, while several others, which do not actually condemn the practice, look upon it with disapproval. Such strictures against smoking have had little lasting effect, however; tobacco has continued to increase in popularity and is now grown and used in almost every section of the world. *See also* INDUSTRIES, EXTRACTIVE.

R. L. F.

**TOBACCO BEETLE,** the common name of a very small, brown beetle, *Lasioderma serricorne,* belonging to the family Anobiidae. It feeds upon dried tobacco, spices, seeds, dried fruits, cereal products, and other materials, and is a serious pest in most parts of the world. The eggs are often laid in tobacco. These hatch after the tobacco has been processed and the larvae bore holes through the finished cigarette.

C. H. Cu.

**TOBACCO WORM,** the common name of the larva of *Protoparce sexta,* a gray sphinx moth, marked with lines of white and black, and, usually, with six orange spots on the sides of the abdomen. It is a serious pest of tobacco. Arsenical sprays have long been used in its control. When undisturbed, it may destroy whole stands of tobacco. C. H. Cu.

**TOBAGO** [tobe′go], an island of the Lesser Antilles, in the West Indies, situated 21 mi. northeast of the British colony of Trinidad, of which it is a part. Its area is 116 sq. mi. and consists largely of a volcanic mountain. The area under cultivation is small, but the land is fertile. Coconuts, sugar, cotton, nutmeg, coffee, and tobacco are grown. There are large reserves of hardwood timber, some of which, along with lime, cacao, and coconuts, are exported. Deer and game birds are in abundance, and snapper, kingfish, grouper, and Spanish mackerel are native to the surrounding waters. The climate during the dry season is pleasant, but is oppressive throughout the wet season from June to December. The average mean temperature is 80° F., and rainfall on the windward side of the island is greater than on the leeward side. Scarborough, once called Port Louis, is the capital and chief town.

Tobago was discovered by Columbus in 1498, and was settled by the Dutch in 1632. Until 1814, when it was ceded to the British Crown, the island belonged, in turn, to the Dutch, British, and French. In 1877 it was made a crown colony, and in 1889 was annexed to Trinidad as a joint colony. By an Order in Council of Oct. 20, 1898, the island became a ward of the United Colony of Trinidad and Tobago. The white population is descended from the Portuguese, French, and British, but the majority is Negro. Pop. 1946, 27,161. S. C. M.

**TOBATA** [tobɑtɑ], an industrial and port city of southwestern Japan. It is on the northwestern coast of Kyushu Island near the western entrance to Shimonoseki Strait, about 10 mi. southwest of Moji. Tobata is a comparatively new city and developed with the industrialization of Japan. It lies within the Shimonoseki-Moji-Yawata heavy industry district and has steel mills, machine shops, oil refineries, glass and cement factories, flour mills, and sugar refineries. The city suffered heavy damage in World War II air attacks in the spring and summer of 1945. Pop. 1950, 87,885.

J. E. F.

**TOBIT, BOOK OF** [to′bɪt], a book of the Apocrypha. It is extant in Greek and in a number of other ancient versions, including Syriac, Latin, and Aramaic. Whether the book was written originally in Greek or in a Semitic language remains a controversial point. Its date of composition is also not certainly known, but it is generally supposed by Biblical scholars that it appeared in its earliest form some time between the third and the first century B.C.

Tobit, the central character of the work, is a righteous man from the tribe of Ephraim who was brought captive to Nineveh by the Assyrians. He prospers in Nineveh and engages in good works, particularly in the burial of the dead, but one night he is stricken blind and prays in his misery for death. At the same time Sarah, a widowed kinswoman of his in Ecbatana, also prays for death, and in answer to these prayers the archangel Raphael is sent to earth. Through Raphael's agency a happy marriage is effected between Sarah and Tobit's son Tobias, and Tobit is cured of his blindness. D. G.

**TOBOLSK** [tʌbɔ′lysk], a commercial town in the Omsk Region of the Russian Soviet Federal Socialist Republic, in the central Soviet Union, about 295 mi. northwest of Omsk. It lies on the high right bank of the Irtysh River opposite the mouth of the Tobol River in the great Siberian lowland. Founded in 1587 by Cossacks on the site of a Tatar village, it was one of Russian Siberia's first towns and became its first diocese. For many years it was an important trading center for furs and fish. Its severe climate and the construction of the Trans-Siberian Railway far to the south led to the town's decline. Economic and administrative functions shifted to Omsk, but Tobolsk continues to have trade in fur, game, and fish. Pop. (est. 1950), 40,000. C. C. H.

**TOBRUCH** or **TOBRUK** [to′bruk], a small port in northeastern Libya, in North Africa, about 75 mi. west of the Egyptian border. It was the scene of heavy fighting early in World War II. The town was captured by the British in their first North African offensive in December 1940, retaken by the Germans and Italians under General Erwin Rommel in June 1942, and recaptured by the British and Australians in November of the same year. Tobruch was developed as a military port by the Italians. It has a small but deep natural harbor and serves as an outlet for the trade of the oases to the south. Pop. 1940, 4,200. A. L. R.

**TOBY, UNCLE,** guileless, lovable uncle of Tristram in Laurence Sterne's *Tristram Shandy.* A retired army captain, he builds miniature fortifications as a hobby and courts the Widow Wadman. W. B. C. W.

**TOCANTINS** [to′kãntī′ns], a river which rises in the state of Goias near the town of Pyrenopolis, central Brazil. It flows northward, forming a section of the boundary between the states of Goias and Maranhão. Near its point of entrance into the state of Pará it is joined by a western affluent, the Rio Araguaia. The northward course of the Tocantins is interrupted by falls and rapids as it crosses the crystalline rocks of the Brazilian highlands. Sixteen hundred miles from its source the Tocantins enters the Rio Pará, the southern estuary of the Amazon River. The Tocantins is navigable for a distance of 120 mi. from its mouth.

P. E. J.

**TOCCATA** [tokɑ′tə] ("touch piece"), a free, virtuosic musical composition especially suited to the keyboard and making use of rapid runs and arpeggios. The toccata figured prominently in the music of the great organists and clavierists of the sixteenth and seventeeth centuries, where its basic, almost Romantic freedom was early offset by alternating fugal sections in the great organ and clavier toccatas of J. S. Bach. This free type of toccata has failed to attract later composers as much as another type, inaugurated by seven-

teenth- and eighteenth-century Italian clavierists: the rapid "perpetual motion" that often borders on the étude. A famous nineteenth-century example is Schumann's Toccata in C major, op. 7 (1830). Debussy, Ravel, Honegger, Prokofiev, and Khachaturian are among twentieth-century composers of extremely effective toccatas. W. S. N.

**TOCCOA** [tɒ′koə], a city in northeastern Georgia, the county seat of Stephens Co., located near the Tugaloo River, 70 mi. northeast of Atlanta. The Southern Railway provides transportation. The city's manufactures include furniture, thread, and machinery. In the neighborhood is Toccoa Falls, 186 ft. high. The city was established in 1872 and incorporated in 1897. Pop. 1950, 6,781.

**TOCHARIAN** [tokɛ′əriən; tokɑ′riən], an Indo-European language which was spoken in earlier times in Central Asia by a people called the Tokhri. Its name is clearly a misnomer, as are "Hittite" and "Hieroglyphic Hittite," but it is by now so frequently used in scholarly works that it will be difficult to replace it. Tocharian is divided into two dialects, frequently called A and B. The speakers of Tocharian A certainly called their own country and language *Ārśi* (*Ārśi-ype, Ārśi-ṣäntu*). The name given to Tocharian B by its speakers is not known.

All of the Tocharian texts (both A and B), with few exceptions, were discovered between 1890 and 1914 in eastern Chinese Turkestan, between the river Tarim and the Tien Shan mountains. The interpretation began in 1907 but proceeded very slowly. The A texts were found only in T'u-lu-fan (Turfan) and Yen-ch'i (Kara Shahr); the B texts were widely distributed. The A texts are exclusively of a religious, specifically Buddhistic, character, and are translations from Sanskrit texts which are now partly lost; the B dialect was used also for medical treatises, legal documents, passports, wall inscriptions, and the like. Some A texts have glosses or titles in the B dialect, and it is therefore possible that B was the living language and A a dead, religious language. Since B was doubtless the language of the kingdom of Kuča (where no A texts have been found), the French scholar Sylvain Lévi proposed the name of Kučean for this dialect, a name which has been widely accepted.

All the B texts date from the seventh century, while the dates of the A texts probably extend from the fifth to the tenth. Both dialects have now been extinct for several centuries and have left no trace.

Tocharian is doubtless an Indo-European language, but it has peculiar characteristics of its own, as, for example, the distinction of the gender in the pronoun "I," where the masculine "I," *näṣ,* differs from the feminine "I," *ñuk*. A sentence like "my love for you" in Tocharian shows immediately whether a man loves a woman, or vice versa (*tñi nukaṃ tuŋk,* but *tñi nṣaṃ tuŋk*). Tocharian has nine cases, which correspond largely to those of the other Indo-European languages in function (it has nominative, genitive, ablative, locative, dative, and instrumental) but not in form. Excepting Irish, Tocharian is the only Indo-European language which entirely confuses the Indo-European velar and labiovelar stops **ḱ* and **ḱʷ*, **g* and **gʷ*, **gh* and **gʷh*. Since all Indo-European stops in Tocharian became nonaspirate and voiceless, all these six (or eight, including **ḱh* and **ḱʷh*) Indo-European phonemes become **k*. Thus Latin *centum* parallels Tocharian A *känt* and B *känte;* Latin *venio,* Greek *βαίνω* and English *come* parallel Tocharian A *kakmu* and B *kekamu;* and Greek *βοῦς*, English *cow,* and Indic *gauṣ* parallel Tocharian A *ko*.

In addition to the *centum* characteristics, Tocharian shows other important connections with Latin and Celtic, such as the endings **-ere* (or **-ero?*) in the third person plural of the perfect (Lat. *tetigere, fecere, dixere;* Toch. A *kaklār, papārsār, yāmär;* Toch. B *weñāre, sākṣāre, wsare*) and the medio-passive in **-r* (Lat. *moritur, sequitur, dicitur;* Toch. A *träṅktar, yärtär, siptär;* Toch. B *yamastr, maskетr, pāṣtar*). But these characteristics (which also survive in Hittite) are mere archaisms preserved in lateral areas. On the other hand, Tocharian shows several innovations in common with Slavic, Greek, and Armenian. In general, Tocharian is certainly an Eastern Indo-European language, largely independent of other Indo-European languages but rather close to Slavic.

Both Tocharian dialects are written in Brāhmi, one of the most frequently used of the Indic alphabets, with some pertinent modifications. The reading of the texts, therefore, presents no particular difficulties. *See also* Lévi, Sylvain; Sieg, Emil. G. B.

**TOCQUEVILLE, ALEXIS CHARLES HENRI MAURICE CLÉREL DE** [tɔ′kvi′l] (1805-1859), French historian and political scientist, was born in Verneuil, July 29, 1805. His education prepared him for the bench, and while still in his twenties he became an assistant magistrate. Soon bored with his duties, he obtained leave to study penal methods in the United States. His book, *La Démocratie en Amérique* (1835), result of a two-year stay in the United States, was the first penetrating analysis of American politics. In America, Tocqueville saw democracy as a system of government which aimed to check absolutism and centralization. He suggested that the leveling of society in American democracy might ultimately weaken resistance to despotism. The publication of this work brought immediate recognition, including membership in the Académie des Sciences Morales et Politiques. He also entered the Chamber of Deputies, becoming vice-president of the Assembly in 1849, and for a few months he served the Second Republic as minister of foreign affairs. Louis Napoleon's *coup d'état* of Dec. 2, 1851, forced Tocqueville into retirement. Returning to his studies, he published in 1856 the first volume of *De l'ancien Régime et la révolution,* which was immediately translated into English. In this classic he reinterpreted the French Revolution as the logical culmination of the Old Regime. His attempted rehabilitation of the Old Regime, though perhaps justified on political grounds, has been all but nullified by the work of historians of the twentieth century. Nevertheless, Tocqueville's study of the Old Regime provided new directions for French Revolutionary studies. He died at Cannes, on Apr. 16, 1859, before completing the later volumes of this last work. R. M. Br.

**TÖDI CHAIN** [tö′di], a part of the northern Alps, located in Switzerland, between the Vorder Rhine Valley and the Swiss Plateau. It is most easily reached from the north by way of Glarus, capital of the canton of the same name in which the chain is situated. The Tödi (or Piz Rusein) is the highest mountain of the range, rising to an elevation of 11,887 ft. Other peaks are Selbsanft (9,935 ft.), Grosse Scheibe (10,023 ft.), and Bifertenstock (11,240 ft.). The Tödi Chain is very popular among mountain climbers and skiers. Passes connect Glarus with the Rhine Valley and can be crossed along easy trails. Most interesting of many valleys is Maderaner Thal, a typical glacial trough (of the Hüfi glacier) with steep slopes rising to snow-clad mountains. S. Van V.

**TOGOLAND,** a trust territory located in West Africa on the Gulf of Guinea and extending inland to 11° 10′ N. lat., between the British Gold Coast on the west and French Dahomey on the east. Germany penetrated from the coast in 1884, 1897, and 1899. Later agreements among Germany, France, and Great Britain fixed the northern territories. German Togoland was surrendered unconditionally to British and French forces in 1914. It was divided between the French and the British in 1919, and in 1922 it was given them as mandated territory of the League of Nations. Following World War II, the United Nations, acting through its Trusteeship Council, assumed supervisory responsibility. As the adjacent Gold Coast, with which part of Togoland has been administered, has become self-governing and is preparing for independence, the question of the future status of Togoland has become critical. The United Nations in 1954 voted to send a special mission to ascertain the wishes of the inhabitants; the mission reported in October 1955 that, in effect, integration with an independent Gold Coast, either immediately for British Togoland or after a prior merger of British and French Togo, appeared the most popular solution, but that a plebiscite was advisable.

From the lagoons of the coast the land rises gradually to 3,600 ft. inland. Streams with waterfalls flow to the coast. The most important of these is the Oti, an eastern tributary of the Volta. Most of its course is in British Togoland, but on its upper reaches it forms part of the boundary between British Togoland and French Togo. The highest part of the territory consists of the Togo Mountains, running from north to south and forming much of the boundary between the two trust territories. The climate on the coast is hot and humid, but on the highlands of the interior it is less enervating. Owing to the abundant rainfall there are long stretches of mangrove swamps and lagoons on the coast, followed by hardwood, dyewood, and oil palm forests; grassland and treeless savannas occur in the north. Corn, yams, cassava, kola nuts, coconuts, and peanuts are cultivated by the natives in the cleared areas.

The population in the south is Negroid, mainly the Ewe tribes, which may be regarded as an offshoot of the Bantu people. In the north Hamitic blood prevails, the chief tribes being the Timi and Dagomba. The majority of the people are pagan, with some Mohammedans in the north, and Christians in the coastal districts.

**British Togoland.** The area allotted to Great Britain as a mandated territory is 13,041 sq. mi., with a population in 1948 or 382,768. Boundary adjustments with the French took place in 1920 by which Lomé and the entire coast were given over to the French in exchange for additional territory in the interior, and further adjustments were made between 1927 and 1929. The northern section of the trust territory is administered as part of the Northern Territories Protectorate of the Gold Coast, the southern section as a division of Gold Coast known as Trans-Volta Togoland.

*EWE PRESBYTERIAN TRAINING COLLEGE, AMEDJOFE, BRITISH TOGOLAND*

COURTESY OF THE BRITISH INFORMATION SERVICES

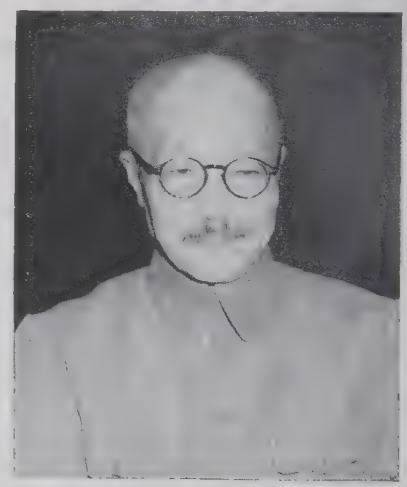
**French Togo.** This region comprises about three fifths of former German Togoland. It has an area of 21,893 sq. mi., with a population in 1952 of 1,029,946. A commissioner, aided by an advisory privy council and an elected assembly, governs the territory, which is also represented in the National Assembly and the Council of the Republic of France and in the Assembly of the French Union. The port of Lomé, the administrative center, is connected with Anécho and Blitta by railway. *See also* EWELAND; GOLD COAST.

W. M. W.

**TOJO, HIDEKI (or EIKI)** [tojo] (1884-1948), Japanese general and statesman, was born in Tokyo, Dec. 30, 1884. His military career included duty as inspector general of army aviation and chief of staff of the Kwantung Army. Belonging to the Kwantung Army clique, exponents of Japanese domination of East Asia by force if necessary, he prepared plans for the "China Incident" of 1937. He was vice-minister and later minister of war in the three Konoye cabinets and was premier from October 1941 to July 1944, resigning with his cabinet after the fall of Saipan. Immediately before his arrest as Japan's chief war criminal, he attempted suicide on Sept. 11, 1945, but recovered and stood trial. Convicted of war crimes on nine counts, Tojo was hanged on Dec. 23, 1948, in Tokyo.

P. S. D.

*HIDEKI TOJO*



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**TOKHARIAN.** *See* TOCHARIAN.

**TOKUGAWA, IYEYASU.** *See* IYEYASU (OR IYEYASU TOKUGAWA).

**TOKUSHIMA** [tokushima], the capital of Tokushima Prefecture on the northeastern coast of Shikoku Island, southwestern Japan. The city has a mild climate. Its hinterland is rugged and heavily forested except for the Yoshino River valley. Tokushima is a cotton-textile center; fishing is also an important industry. The city developed around a small hill fortified by a castle which was destroyed in the Restoration Wars in 1868. The castle site is now Tokushima Park. Komatsushima, 7 mi. southeast, is the port for Tokushima. Pop. 1952, 133,332.

J. E. F.

EWING GALLOWAY

*STROLLERS IN UYENO PARK, ONE OF TOKYO'S MANY FINE PARKS*

**TOKYO** [tokyo; to′kio], the capital of Japan and one of the world's largest cities, 220 sq. mi. in area. It is on the east central coast of Honshu Island at the northwestern end of Tokyo Bay and at the mouth of the Sumida River. The mean annual temperature is 57° F. About 64 in. of precipitation falls annually. September is the wettest month and December the driest.

Tokyo was formerly called Edo, or "Estuary Gate," and in the twelfth century it was a small village. In 1590 Iyeyasu, founder of the Tokugawa shogunate, made it a provincial capital, and after he became a shogun in 1603 the city increased in size; eighty thousand retainers, in addition to the families of most of the nobles who were required to live in the city as hostages, swelled the population. The swamps were drained, canals were built, and streets were widened. In 1731 the population was 561,900, and by 1787 it numbered 1,367,900, making Edo one of the largest cities in the world. In 1868, when the imperial regime was restored, Edo became the capital of Japan and the name was changed to Tokyo, or "Eastern Capital."

In the center of the city is the Imperial Palace, from which the principal streets radiate. Tokyo is divided into two general areas: the Yamate, or residential section on the higher parts of the city, and the Shitamachi, or commercial and industrial area. The center of the commercial district is the Marunouchi, which has many large modern buildings. The Nihombashi commercial area is also important, and the Ginza street is the principal shopping center. Though Tokyo is best known as the educational, cultural, financial, and administrative center of Japan, it rivals Osaka in the diversity and importance of its industries, heavy industry alone being relatively unimportant. There are more than 200 mi. of trolley lines, two important subways, and many canals in the city.

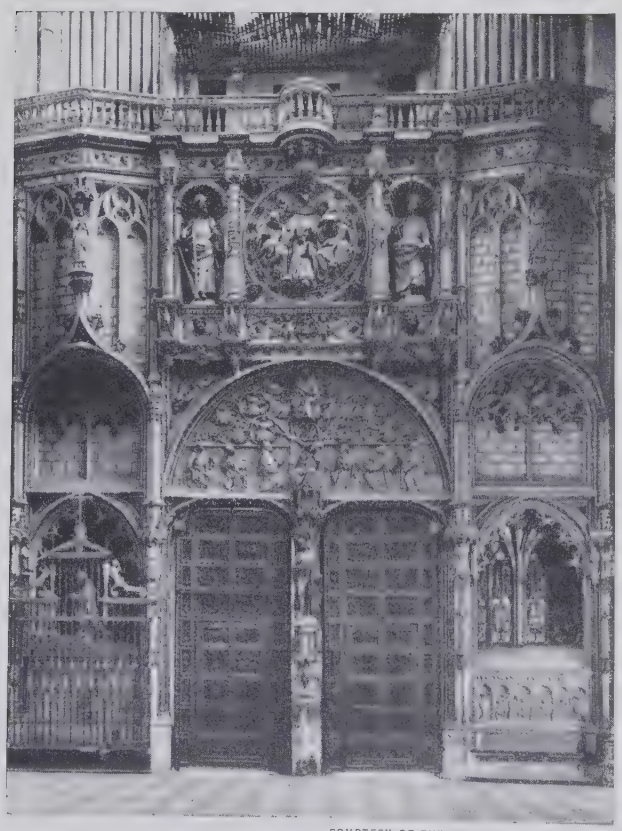
Among Tokyo's many museums are the National, Metropolitan Art, Modern Art, Okura Art, Bridgestone, Military, Patent, Transportation, Communications, Folkcraft, and Science museums. There are also many zoological and botanical gardens, Christian churches and meeting places, and famous Shinto shrines such as the Yasekuni, Meiji, and Nogi. Millions worship at the Meiji Shrine and visit the 175-acre gardens surrounding it. There are numerous national, prefectural, and municipal government buildings, banks, large stores, and hotels, among which the Imperial Hotel designed by Frank Lloyd Wright in 1915, fronting on Hibiya Park, is the most famous. Other large parks are the Asakusa, Sumida, Shiba, and Uyeno. Greater Tokyo has a total of 137 institutions of higher education, 11 being National Universities, including Tokyo University.

The earthquake and fire of 1923 destroyed a large part of the city, which was rebuilt in modern Western style. The shallow harbor was dredged to allow 6,000-ton vessels to dock. Larger ships dock at Yokohama. Tokyo was repeatedly bombed in 1945 by both carrier-based planes and B-29's. On Mar. 9, 1945, about 15 sq. mi. of the city was burned, and again on April 13 about 5 sq. mi. were burned. Modern office buildings withstood the air attacks fairly well, but residential and older areas were destroyed. The surrender of Japan after World War II took place on the U.S.S. *Missouri* in Tokyo Bay, Sept. 2, 1945, and Gen. Douglas MacArthur, Supreme Allied Commander, established his headquarters in Tokyo. Pop. 1954, 5,385,071.

**TOKYO UNIVERSITY,** at Tokyo, Japan, founded in 1877 as the Tokyo National (Imperial) University. It began as a merger of three institutions: Shoheiko (1790) for the study of Confucian classics, Kaiseigo (1855) for occidental learning, and Igakusho (1863) for the study of occidental medicine. In 1947 "Imperial" was deleted from the title and its present name became official. Associated with the university are a number of institutions: Tokyo Astronomical Observatory (1888), Historiological Institute (incorporated 1888), Institute for Infectious Diseases (incorporated 1916), Aeronautical Research Institute (founded 1918 and abolished in 1946), Earthquake Research Institute (1925), Institute for Oriental Culture (1941), Radiation Chemistry Research Institute (1945), Physiographical Science Research Institute (1946), Institute of Science and Technology (1946), and Institute of Social Science (1946). The present university departments include engineering and industrial engineering, agricultural science, literature, medicine, law, and education; with a faculty of 863 members and a student enrollment in 1948 of 10,717. Of particular interest are the main library and its 140 branches with a total of nearly 1,277,000 volumes. After destruction by earthquake of the original structure, the present main building was built in 1928 with a fund of 4,000,000 yen donated by John D. Rockefeller. In addition to this university library there are nine other affiliated university libraries in Tokyo with a total listing of 1,605,463 volumes. A. L. H-Q.

**TOLEDO** [tole'tho], a province in central Spain and its capital city. The province was once a part of New Castile, of which Toledo, the city, was capital.

**The City.** The city of Toledo is situated on a steep, rocky hill on the right bank of the Tajo (Tagus) River, about 40 mi. southwest of Madrid. The gorge of the Tajo bounds the city on the east, south, and west; to the north lie a double wall and steep cliffs. Two ancient bridges cross the Tajo at Toledo: one, the Puente de Alcantara, was constructed by the Romans and was later rebuilt by the Arabs in 977 and by the Castilians in 1258; the other bridge, the Puente de San Martín, was erected in 1212. Toledo lies at the end of a branch line of the railway running through Aranjuez to Madrid. It has a continental climate, with hot summers and cold winters, and has an average of 14 in. of rainfall annually.



COURTESY OF THE SPANISH TOURIST OFFICE

*THE FAÇADE OF THE CATHEDRAL IN TOLEDO, SPAIN*

Toledo's history goes back to the Greeks and Phoenicians. A flourishing city by the time of the Roman Empire, it assumed even greater importance in the sixth century when the Visigothic kings made it their residence. The Moors captured Toledo in 712 and made it their military headquarters for that part of Spain. The Toledans frequently rebelled, and established their independence on several occasions. The Arab influence was strong, however, and many of the Spanish and Jewish natives of the city adopted Moorish ways and the Arabic language. After Alfonso VI of Castile captured Toledo in 1085, with the aid of the Cid, these Mozarabs, or "half-Arabs," were allowed to speak Arabic for almost five centuries, until the Inquisition forced them to return to Spanish ways. In 1561 Philip II moved his capital from Toledo to Madrid, and from that date the city declined. The population of Toledo in 1950 numbered little more than one fifth of the 200,000 it is said to have totaled at one time.

Sprawling unevenly over the hilly terrain, Toledo is a veritable museum of history and architecture. The fundamental Moorish aspect of the city remains despite the fact that the Christian reconquerors rebuilt half of Toledo. Steep, narrow, winding streets, many of which are cul-de-sacs, add to the Moroccan appearance. The houses, for the most part, are built around interior patios and there are few public squares or plazas. Although Toledo is the central market town for the surrounding area, traffic in the city is almost never heavy. The Cathedral, in the center of town, marks the site of a sixth-century Visigothic church and a later Moorish mosque. It was completed by 1493 and is a striking combination of architectural styles but, unfortunately, is hemmed in and all but surrounded by other buildings. Many other churches, several of them rebuilt from Moslem mosques, stand in the city. The Alcazar, a huge, square edifice with towers at each corner, stands on the highest ground in Toledo and dominates the city. Once the palace of Castilian monarchs, it has been utilized as a fortress and as a school, and has been burned and damaged many times, most recently in 1936 during the Spanish Civil War, when a group of Insurgents withstood a Loyalist siege for 70 days.

Once one of the great cities of Spain, Toledo now has little commercial or political importance. Aside from the continued production of "Toledo blades," swords of remarkable quality famous since Roman times, Toledo depends on the tourist trade and its position as provincial market center for its economic livelihood. It still retains much of the religious importance that it has held since the pre-Moorish Councils of Toledo, and is the seat of the Catholic primate of Spain. Pop. (off. est. 1947) 40,210.

**The Province.** The province of Toledo, located in the geographical center of Spain, has an area of 5,919 sq. mi. and is bounded on the north by the provinces of Avila and Madrid, on the east by Cuenca, on the south by Ciudad Real, and on the west by Cáceres. The province lies within the watershed of the Tajo River, except for the southeast corner, which is drained by tributaries of the Guadiana. The prov-

ince extends into the foothills of the Sierra de Gredos in the northwest while the Montes de Toledo run along the southern border. Irrigation is practiced along the valleys of the Tajo and its principal tributary, the Alberche, and agriculture flourishes in these areas. Wheat and other cereal grains, grapes, and citrus fruits are grown successfully. In the higher regions of the province where sheep raising is important, the population is relatively sparse. Much of the land in the province is owned by absentee landlords, and the inhabitants tend to congregate in small urban settlements. There is almost no mining and only a few, small, traditional industries. Several of the railroads radiating from Madrid pass through the province.

Toledo, the capital, is the largest city, while Talavera de la Reina, near the confluence of the Tajo and the Alberche, and Mora are other towns of importance. English forces, led by Arthur Wellesley (later Duke of Wellington) defeated the French under Joseph Bonaparte at Talavera de la Reina in 1809. Pop. 1950, 533,654. R. G. W.

**TOLEDO** [toli'do], a city and port of entry in northwestern Ohio, the county seat of Lucas Co., situated at the mouth of the Maumee River. The largest river flowing into the Great Lakes, the Maumee empties into Maumee Bay at the westernmost tip of Lake Erie, 113 mi. west of Cleveland. Toledo lies on both sides, but mostly on the west bank of the river, over which are 9 connecting bridges. A natural harbor, extensive water frontage, a deep channel, and 14 railroads combine to make Toledo a center for rail- and water-borne commerce. The city ranks eighth among ports of the United States in tonnage handled and second among cities on the Great Lakes. A leading coal port, it handles approximately half the total coal tonnage of all the Great Lakes ports combined. Much iron ore, grain, and oil clear through the port, which has direct oil pipeline connections with the Oklahoma oil fields. Passenger transportation is provided by the Baltimore & Ohio, Chesapeake & Ohio, New York Central, Pennsylvania, and Wabash railroads, and the Capital, Delta-C&S, Trans World, and United airlines.

After the Battle of Fallen Timbers (Aug. 20, 1794), about 12 mi. southwest of Toledo, Gen. Anthony Wayne built Fort Industry, and on that site a few years later the village of Port Lawrence was established. A rival village, Vistula, was formed a mile away and in 1833 the two joined to become Toledo and were finally incorporated as a city in 1837. During this interval the so-called Toledo War took place between Ohio and Michigan in a boundary-line dispute over the Toledo strip. Congress decided in favor of the Ohio claim in 1836. Samuel M. Jones, known as "Golden Rule Jones," was elected mayor on a nonpartisan ticket and served from 1897 to his death in 1904. The "Golden Rule" policy practiced in his business continued in his private war on the misuse of public funds, bossism, and favoritism in city government. Brand Whitlock, his successor, carried on the independent movement for four terms. In 1934 Toledo adopted the city-manager form of government.

Educational and cultural facilities in the city include the University of Toledo, Mary Manse College for Women, and the Toledo Museum School of Design. The Toledo Museum of Art has one of the finest collections of glass in the world. The Zoological Gardens rank among the nation's finest. Another point of interest is Our Lady of the Holy Rosary Cathedral, an outstanding example of Spanish architecture. Fort Meigs State Park is about 12 mi. south of Toledo. Remnants remain of the fort built by General Harrison during the War of 1812. The Anthony Wayne High Level Bridge, one of the largest full suspension-type structures in the Midwest, spans the Maumee River.

Toledo is a center for the manufacture of glass, and automobiles, spark plugs and other motor accessories, oilfield equipment, and plastics are important. Other products include automatic scales, gas furnaces, leather, canvas goods, machinery, die castings, metal stampings, and clay products. The city has railroad shops and shipyards, and stone, gypsum, and cement quarries are in the vicinity. Milling is an important industry, since Toledo is in the grain belt and huge grain elevators are available for storage. The city is also a leading market for hay, clover seed, coffee, and spices. Pop. 1950, 303,616. H. S.

**TOLEDO, UNIVERSITY OF,** an accredited, coeducational, municipally controlled institution situated on a campus of 160 acres in Toledo, Ohio. It was chartered as a private institution in 1872. In 1884 the city of Toledo took over the university. The numerous divisions of the university were founded as follows: College of Medicine, 1894 (discontinued, 1912); College of Arts and Sciences, 1909; Graduate Study Division, 1912; College of Education and Junior College, 1916; College of Business Administration and College of Engineering, 1930; College of Law, 1934; College of Pharmacy, 1938; and General Division, 1945. Degrees offered include the A.B.; B.S.; B.S. in medical technology, nursing, and liberal arts; A.B.; B.B.A. and B.B.S. in business administration; A.B., B.S., B.Ed., and Bachelor of Vocational Education in education; B.S. in chemical, civil, electrical, mechanical engineering and engineering physics; LL.B.; B.S. in pharmacy; M.S.; M.B.A.; and M.A. Two-year certificates are conferred by the junior division. Military science is optional in the Army R.O.T.C. unit. A few scholarships are available, and there is a small student-loan fund. There are dormitories for men and women who do not commute. Fraternities and sororities exist on the campus; some undergraduates live in their chapter houses. *For statistics see* COLLEGES AND UNIVERSITIES. J. R. To.

**TOLERANCE.** Tolerance may be defined as the inclination and capacity to establish and preserve community with people who differ in some respect from the general type or consensus. Tolerance is a difficult and a rare achievement for the simple reason that consciousness of kind is the primary basis of community. We are drawn together in community with those who share our convictions, or who have a common language or culture with us, or who belong to our ethnic group. Common language and the sense of ethnic kinship are, in fact, the most primordial bases of community through all the centuries. On the other hand, we tend to be hostile to, or fearful of, those who are "different." The difference may be on any level of biological, cultural, or political reality.

Toleration is thus a necessity of health for both the individual and society. No individual can be healthy without learning to "get along" with people who differ from him in one or many respects. On the other hand, toleration is the necessary price of social peace in any creative community.

The ability to get along with people who are different has always been a rare personal achievement and a communal necessity throughout human history. But it has become an even more urgent problem as modern communities became ever more pluralistic.

Modern national communities, and, above all, the nascent world community, have nevertheless established, or are under the necessity of establishing, community among people who

diverge from a type, or challenge one another's basic convictions, or compete with cherished interests. All modern nations are culturally, religiously, and politically more pluralistic than the traditional communities of human history, which maintained their unity upon the basis of fundamental conformities in culture or religion. Conformity as a basis of community was, in fact, regarded as so necessary that even after the Renaissance and the Reformation destroyed the uniformity in the culture of Europe, the treaty of Westphalia, ending the thirty years of religious wars, provided for the religious conformity of particular communities through the formula *cuius regio, eius religio*. This formula insured at least conformity between the prince and the people in matters of religion.

Cultural and religious pluralism nevertheless entered Western culture, particularly in the Anglo-Saxon world, and the tolerance required to establish community under the conditions of pluralism was, on the one hand, the necessary by-product of this pluralism and, on the other hand, the precondition of the further development of pluralism.

The decisive chapter in the history of toleration was enacted in the Cromwellian period of seventeenth-century England. In that period, the various Puritan sects which composed Cromwell's army broke the cultural and religious unity of the nation. Only the Independents and the Levellers were honestly interested in liberty and toleration. Their commitment to the principle of liberty was a necessary precondition of the pluralism because they stated the principles which would validate toleration. Those principles were that no conviction was so infallible as to warrant the suppression in its favor of other convictions in a community. Said John Saltmarsh, one of the great proponents of toleration in the Cromwellian period, "Thy evidence is as dark to me as my evidence is dark to thee until the Lord enlighten all our seeing."

On the whole, toleration was established in both England and America, not so much as an ideal principle, but under the compulsion of necessity, once the monolithic unity of the society had been destroyed. It was found, in short, that a community would have more peace without the attempt to superimpose religious unity than if that attempt, usually abortive, were made. Thus the community, under social necessity, achieved toleration and peace far beyond the ideals of the various warring groups.

In our own nation, this cultural and religious pluralism was even more an established fact, even though the New England colonies were originally lacking in every inclination toward toleration. But in the great struggle of the Revolutionary War of independence, the various colonies with their disparate religious cultures were welded together into a single nation.

It therefore became an absolute necessity to build our national community upon the basis of toleration. Many of our founding fathers, particularly Jefferson and Madison, genuinely believed in toleration; but those who did not believe were nevertheless persuaded to accept toleration because the religious pluralism of the new national community made any other alternative unthinkable.

This experience suggests that the requirements of social peace under conditions of pluralism are actually the chief incentives to toleration. We establish community with those who are different simply because we are thrown into a situation of potential community with them. We are thus forced to restrain our impulse to establish community only with those who are like us, or think as we do.

Inevitably, some lessons are learned from these necessities which support the thesis of the idealists who advocate tolerance for the sake of giving the community richness and variety and for the sake of emancipating the individual from restraining conformity to common cultural standards. Tolerance is not merely a necessity of social peace under conditions of cultural, religious, and ethnic heterogeneity. It is a requirement for the enrichment of the community as well as for the emancipation of individual creativity from the restraining conformity of the community.

It is significant that the problem of toleration first arose on the religious level in Western civilization; and that religious toleration became the seed of all the freedoms which have developed in a free society. It is sometimes assumed that toleration of men who hold different religious convictions is the most difficult of all achievements. This judgment assumes that religion is inherently fanatical—and this, indeed, is partly the case, in the sense that religion deals with ultimate commitments which engage the whole of the person. Ideally, a true faith should generate charity rather than fanaticism, because it subjects fragmentary and parochial historical values and commitments to the scrutiny of the ultimate and divine. But actually, the religious person is easily tempted to sanctify his parochial values by the sanctity of the absolute of his devotion; and to claim God as an ally for his cause. Therefore, religion tends to add a particular depth and virulence to parochial fanaticisms, whether they be cultural, national, or ethnic. It is, however, erroneous to assume that religion is the only source of fanaticism and that its abolition would create the spirit of tolerance.

The Enlightenment of the eighteenth century, which is frequently credited with the spirit of toleration, generated a very virulent Jacobin rationalistic fanaticism. The only significant champion of toleration in the Enlightenment was Voltaire. The dictum attributed to him, "I disagree with what you say, but I will defend to the death your right to say it," expressed the classical theory of toleration. But it is fair to remark that Voltaire acquired this spirit from enviously observing the social peace of England under conditions of religious pluralism and the beneficent effects of the religious toleration established there in the seventeenth century. France did not acquire this social peace and toleration for many years, not only because of the fanaticism of the defenders of the traditional society and culture, but because of the fanaticism exhibited by the rationalistic defenders of the new culture.

The fact is that any commitment, religious, political, or cultural, can lead to intolerance if there is not a certain degree of residual awareness of the possibility of error in the truth in which we believe, and of the possibility of truth in the error against which we contend. It is an ironic fact that the modern generation which celebrated its emancipation from traditional religious fanaticisms has been engulfed in the strife between fanatic political creeds which did not allow any community at all except on the basis of political conformity.

These new political fanaticisms threaten to destroy free communities in which the original cultural and religious tolerance has been elaborated into both political and economic freedom. Political freedom requires that the political opponent be trusted sufficiently to permit the opposition to campaign and organize in order to supplant the regnant government. Economic freedom requires the toleration of competitive economic interests. Such competition, with proper safeguards, has made for a more harmonious community, offering incentives to the initiative of various per-

sons and groups, which has proved more vital than the social peace maintained by the fiat of governmental intervention. In short, the "limited warfare" in the field of both politics and economics, which is so necessary for the vitality of modern society, is the last fruit of the attitude of toleration which includes not only the person who is "different," but the opponent.

Toleration of persons who are different in kind requires an awareness of the similarities and identities above and beneath the differences; it requires an awareness of a common humanity, for instance, underneath ethnic distinctions. It is therefore a spiritual achievement of great moment. Toleration of people who differ in convictions and habits requires a residual awareness of the complexity of truth and the possibility of opposing views having some light on one or the other facet of a many-sided truth. In that sense, what the orthodox conformist would define as heresy in either politics or religion may frequently be only an awareness of a neglected facet of the truth. The capacity to comprehend various facets of a truth, or to become aware of the parochial nature of the truth to which one is committed, may be both an intellectual and a religious achievement. It may be achieved, at any rate, both by a rational and discriminating analysis of the complexities in which any truth is inevitably involved and by a spirit of religious humility which is willing to recognize the conditioned character of the historical formulation of even the most ultimate and absolute truth.

While tolerance, or the capacity to establish and preserve community with people who differ from us in any respect, must therefore be regarded as a virtue which may be as rare as it is valuable (since the natural inclination of human nature is to be in community on the basis of consciousness of kind), there are nevertheless two limits to the virtue of tolerance. One of those limits is the tendency of toleration to result in a spirit of indifference to values which ought to secure commitment. "Tolerance is a virtue of people who don't believe in anything," declared Gilbert Chesterton, in calling attention to one of these limits. Unless the spirit of toleration involves a clear and firm commitment to a higher value than the ones in dispute, it may empty life of meaning and importance.

The other limit of tolerance is given by two necessities. The one is the necessity of establishing minimal standards of moral decency from which the community cannot allow serious deviations. The other arises from the necessity of protecting the community against conspiracies and treason, particularly against treason originated by fanatic and totalitarian political movements which would annul the freedom and justice of the community. But even in this realm, in which the standard must be to be intolerant of intolerance, it is necessary to preserve discriminate judgment, lest divergence from a traditional norm be falsely defined as treason against the basic value of freedom and toleration. In most modern free communities, for instance, the debate on how much or how little economic enterprise shall be politically regulated for the sake of preventing catastrophic fluctuations and insuring minimal standards of social well-being and security, is inevitable and necessary. It is also, and must remain, inconclusive, since the values of freedom and security are both desirable and, in some respects, incompatible. Whether one or the other is preferred is determined, on the whole, by ideological presuppositions of the various classes. Those who have security, whether by their own skills or by their wealth, will prefer liberty over security; while the industrial workers will prefer security to liberty. There is no way of dissolving these ideological preferences, or of resolving the debate between the classes about these preferences. Therefore, every modern democratic society must guard against incorporating one or the other preference prematurely into the basic norms of society. The debate must be kept open and society must achieve peace through the tolerant attitude of each side toward its ideological opponents. In this, as in other cases, a free society must rely on the "limited warfare" which is the prerequisite of community under conditions of freedom. Such limited warfare is the essence of the creative tension between opposing economic and political forces within the framework of social peace. It can be successfully maintained only in the spirit of toleration, that is, by the achievement of the capacity to preserve community with those who differ from us. R. N.

**TOLERANCE** and **ALLOWANCE,** the deviation between the nominal dimensions and the fits of mating parts. In actual manufacture, exact dimensions never exist. The variation in the size of parts can be reduced but never can be eliminated entirely. It is neither possible to gauge parts absolutely accurately nor to set machinery in such a way that one part will be exactly like another. It is necessary, therefore, in order to make large-scale manufacturing possible, to permit some variation in the size of parts without impairing their performance. This permissible deviation in dimensions of parts from a nominal dimension is called tolerance, which may vary from 1/64 in. to a few millionths of an inch, depending on the intended purpose. In general, the smaller the tolerance, the greater the cost per unit. Tolerance may be either unilateral or bilateral. Unilateral tolerance means that the deviation in the nominal dimension or basic dimension is in one direction only, whereas for bilateral tolerance it may be either greater or less. For example, if the dimension of a part is given as $2.000\ ^{+\ 0.003}_{-\ 0.000}$ in. the tolerance is unidirectional; if the dimension is given as $2.000 \pm 0.003$ in., the tolerance is bilateral.

In order to permit assembly of parts and to permit their proper performance, it is necessary to specify a certain minimum clearance between mating parts. This minimum clearance is called the allowance, and is determined in the case of a hole and its mating shaft by the largest shaft and the smallest hole. To illustrate tolerance and allowance, assume the following dimensions: shaft diameter, $1.496\ ^{+\ 0.002}_{-\ 0.000}$ in.; largest shaft, $1.496 + 0.002 = 1.498$ in.; smallest hole, $1.500 - 0.000 = 1.500$. Here the allowance is 0.002 in., and accordingly the tolerance of the shaft and hole is 0.002 in. E. T.

**TOLERATION ACT,** a statute granted by William and Mary in 1689 providing a certain measure of equality to English Protestant Nonconformists. The Protestant Nonconformists had rejected the Roman Catholic James II's offers of toleration and had joined the Church of England in driving him off the throne. They had to be rewarded, but were compensated grudgingly. The repressive acts of the Clarendon Code were not repealed but merely suspended in favor of anyone who would take the oaths of allegiance and supremacy and make the declaration against transubstantiation; thus the members of the Roman Catholic Church were excluded from toleration, and by the earlier Corporation Act of 1661 and Test Act of 1673, Nonconformists

were still legally excluded from civil, municipal, and military office. E. R. A.

**TOLGUACHA** [tɒlgwɑ′tshə], a beautiful herbaceous perennial, *Datura meteloides,* a member of the nightshade family, growing about 2 ft. high. It has fragrant, trumpet-shaped flowers, often becoming as large as 6 in. across. In color these flowers are white, tinged with violet or purple. The leaves are grayish, and are borne on slender, forked stems. This perennial is native to the southwestern United States, and is often cultivated in gardens as an annual. Because of its narcotic properties, the plant was used medicinally by various Indian tribes. M. G. W.

**TOLIMA** [toli′mɑ], a dormant volcano of western Colombia and the second highest peak (18,438 ft.) of the Colombian Andes. It is situated 15 mi. north of Ibagué and its snow-capped summit is visible from Bogotá, 80 mi. east. The peak towers above the crest level of the Cordillera Central. It overlooks the Quindío Pass, through which runs the highway connecting the Magdalena and Cauca valleys. P. E. J.

**TOLLER, ERNST** [tɔ′lər] (1893-1939), German dramatist, was born in Samotschen, Prussia, Dec. 1, 1893, the son of a Jewish merchant. After studying in the *Realgymnasium* at Bromberg and the University of Grenoble, he served on the western front in World War I until invalided home in 1916, when he enrolled at the University of Munich. He joined Kurt Eisner in the revolutionary strike of 1917 and

ERNST TOLLER

BROWN BROS.

was imprisoned, but in 1918 he became a member of Eisner's Bavarian government and head of the council of workmen, peasants, and soldiers. Toller was implicated in the Munich Communist rebellion, was arrested in 1919 and sentenced to five years of "honorable fortress imprisonment," and in 1924 was exiled to Saxony. His first satirical farce, *Wotan Unchained,* written in prison, uses Adolph Hitler as the model of Wotan, the barber-orator, who becomes dictator of an antidemocratic and anti-Semitic movement which promises everything to its followers. He was exiled from Germany in 1933 and committed suicide in New York, May 22, 1939. *Masses and Man* and six of his other ideological plays have been translated into English. He also wrote *No More Peace; Pastor Hall;* an autobiography, *I Was a German;* and several volumes of verse, most of which were composed in prison. R. H. L.

**TOLSTOY, ALEXEI KONSTANTINOVICH** [tʌlstɔi′, tɒlstɔi′] (1817-1875), Russian poet, novelist, and dramatist, was born in St. Petersburg, Aug. 24, 1817. He spent most of his early years on his uncle's estate in the Ukraine, and traveled widely. A friend of Alexander II, he declined the Tsar's appointment as aide-de-camp and contented himself with the honorary title of court huntsman, a post that gave him unlimited opportunity for the pursuit of his two favorite hobbies, hunting and art. He lived a peaceful and relatively uneventful life as an aristocratic gentleman. His first novel, *The Vampire* (1840), was based on Italian life, but he is best known for his ballads, based largely on Russian history; his historical novel, *Prince Serebryany* (1863), set in the time of Ivan the Terrible; and his dramatic trilogy (1866-1870): *The Death of Ivan the Terrible, Tsar Fyodor,* and *Tsar Boris.* The last two plays were for many years under the ban of the censor, for in *Tsar Fyodor* Tolstoy showed the tragic fate of the kindly Fyodor, who, pathetic in his desire to do good, was unable to find his way amid the troubled politics of the day and brought evil on all whom he desired to help.

Tolstoy was a confirmed Westerner and perhaps appreciated better than any other Russian author the real significance of the Western belief in freedom and human dignity. He visualized this as existing in Kiev before the time of the Tartar invasions, and he contrasted this free and civilized existence, when Kiev formed part of the Western world, with the rigid tyranny of Ivan the Terrible and the system of Moscow, which still continued in his own day. Among his outstanding poems are *St. John Damascene,* in which he emphasizes the freedom of art, and the *Dragon,* a tale of Renaissance Italy. There was nothing pompous or stiff about Tolstoy's writings, and he composed a number of satires, among them a comic history of Russia, emphasizing the Russian search for order, and the *Hero Potok,* criticizing both the tyranny of Moscow and the absurdities of the radicals of his own day. In the same vein, Tolstoy and his cousins, Alexei and Vladimir Mikhailovich Zhemchuzhnikov, created the character and writings of Kozma Prutkov, one of the most amusing hoaxes in Russian literature. Prutkov was represented as a thoroughly limited bureaucrat with ambitions to become a writer; the tastelessness of his poems and his general stupidity satirically demolished the literary claims of many minor writers who were being overpraised by some of his contemporaries.

Tolstoy died on his estate of Krasny Rog, Sept. 28, 1875. He was much criticized for his failure to join any of the social schools of the day, but his humane spirit, his high ideals, and the beauties of his work assure him of a high place in Russian literature. C. A. M.

**TOLSTOY, ALEXEI NIKOLAYEVITCH** [tʌlstɔi′; tɒlstɔi′] (1883-1945), Russian novelist and playwright, was born Jan. 11, 1883, in Sosnovka, a village in the Samara region. His father was a small landholder and his mother a minor writer. He was a distant relative of Count Leo Tolstoy. His activity as a writer began in 1907 with the publication of a book of lyric poems, and continued through World War II until his death on Feb. 23, 1945. During that time he produced many novels, short stories, and plays on a great variety of themes. His reputation was already established before World War I with a number of stories dealing with the life of the Russian country gentry.

His most important contribution to Russian letters falls within the Soviet period. He did not at first accept the Revolution, and chose to spend the early years of the Soviet

regime in exile in Paris (1918-1921). Later he became reconciled to the new order, and after his return to the U.S.S.R. was one of the leading figures in Soviet literature, having been decorated for his services as a writer and twice awarded the Stalin Prize for outstanding contributions to literature.

In the middle twenties Tolstoy wrote a number of fantastic stories: *Aelita* (1922), dealing with a social revolution on Mars; a play, *The Revolt of the Machines* (1925); and *Engineer Garin's Hyperboloid* (1926), the story of a scientific superman who attempts to enslave the world. *Azure Cities* (1927) describes the struggle of modern science with the primitive backwardness of the Russian village. *Road to Calvary,* a trilogy begun in Paris in 1921 and completed in 1941, is his most important single work, giving a realistic picture of Russian society, especially the upper-class intellectuals, through the years of war and revolution. His *Peter the Great* (1934) is regarded as the best Soviet historical novel. In World War II Tolstoy was active as a journalist and a writer of war stories.

Tolstoy is significant chiefly as a novelist who has continued into the Soviet period the tradition of Russian psychological realism, and as one of the leading Russian writers of historical fiction. E. J. B.

**TOLSTOY, COUNT LYEV NIKOLAYEVICH** (1828-1910), Russian novelist and writer on religion and ethics, was born Sept. 9, 1828, at Yasnaya Polyana, near Tula. After study with private tutors, he attended the University of Kazan, but did not graduate. In 1851 he went to the Caucasus, where in the next year he entered the army and served in campaigns against the mountaineers and in the defense of Sevastopol, leaving the army in 1856.

Tolstoy's first published works, dating from 1851 to 1856 (*Childhood, Boyhood, and Youth; Sevastopol Sketches;* and other tales), already show his distinctive methods. He is primarily interested in character, paying little heed to his plots, and he describes his character mainly by citing small acts that illustrate emotions and motives. He is preoccupied with the moral life, showing his heroes trying to be good, stumbling and failing, but never deserting their ideals. He gives wonderful descriptions of external incidents and of scenery, but always from the point of view of the actors in his stories.

During the period 1856-1862 Tolstoy was absorbed in the education of peasant children and wrote little fiction. He conducted a school on his estate, studied educational systems during a trip to western Europe, and also published a small pedagogic magazine. He reacted violently against the prevailing methods of education, maintaining that a teacher must aid a child to develop his own capacities and that in doing so, the teacher may impart useful knowledge, but not his own point of view. Governmental interference in education Tolstoy regarded as harmful; his mental outlook was already fundamentally anarchistic.

In 1862 Tolstoy married and settled down on his estate of Yasnaya Polyana. The next sixteen years saw his most copious artistic production—*War and Peace* (1863-1869) and *Anna Karenina* (1873-1878). His writings always being autobiographic, Tolstoy showed himself dominated by the interests of family life, a life that had rescued him from dissipation. While in his earlier writings women had been comparatively unimportant, he now drew them with marvelous skill.

Meanwhile he had been experiencing a religious crisis. Life ceased to have a meaning for him, and he learned that it was equally meaningless to all intelligent men of his own class. He yearned to kill himself, but he saw that the peasants, through their religion, found life profitable and full of meaning, and he therefore accepted the religion of the Russian Church, only to have his moral nature revolted by its denunciation of other faiths and by its apology for war. He strove to formulate a religion of his own on the basis of Christ's teaching in the Gospels, and a short, vehement, autobiographic work, *My Confession* (1879), tells of his religious struggles.

In 1880 Tolstoy wrote his *Critique of Dogmatic Theology,* which concludes with an indictment of the Church teaching

*COUNT LYEV NIKOLAYEVICH TOLSTOY*

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that blasphemy against the Holy Ghost is the unpardonable sin. Meanwhile he studied Greek and, in the years 1880-1882, composed his *Harmony and Translation of the Four Gospels,* which he regarded as his greatest work. He found the central doctrine of Christ in the words, "Resist not the evil-doer; but whoever smiteth thee on the right cheek, turn to him the other also" (Matt. v: 39). Of his ethical system he gave a popular exposition in *What I Believe* (or *My Religion*) (1883). Since all government depends on resistance to evil men, Tolstoy argued, no true follower of Christ can share in military or civil administration or even hold property. He developed further this doctrine of Christian anarchy in *What Shall We Do Then?* (1884-1886), with its heartbreaking picture of the Moscow slums, and *The Kingdom of God Is Within You* (1891-1893). Of all these works only fragments could be printed in Russia; they were published in full in Switzerland or in England. Tolstoy believed fervently in God, but thought that any attempt to define His nature removed men from Him. Jesus he regarded simply as a man, a great teacher. In *What I Believe* he rejected the doctrine of immortality; in 1898 he returned to faith in it.

During 1878-1885 Tolstoy wrote no fiction save a few short stories, mainly didactic. In 1886 he produced *The Death of Ivan Ilyich,* a tale some eighty pages long, and *The Power of Darkness,* a drama. Unlike his earlier fiction, these powerful works concentrate on the portrayal of suffering, meanness, and crime; their leading characters have at last glimpses of a regenerate life. As time passed Tolstoy became a more and more relentless puritan. In *What Shall We Do Then?* he exalted family life, but in *The Kreutzer Sonata* (1889) he reversed his position, finding the sex instinct inconsistent with true religion, and advocated absolute chastity as a universal ideal. Yet in the same year he wrote a jovial comedy, *The Fruits of Enlighten-*

*ment,* and in 1901 he composed *Hadji Murad,* a story in which he pictured admiringly a Mohammedan warrior of the Caucasus who stoutly resisted Russian rule. In 1897 he published *What Is Art?,* a treatise containing much pungent criticism from the point of view of his own ethical system.

Beginning in 1881, for the sake of the education of the children, the Tolstoy family lived largely in Moscow. Tolstoy's religious views caused conflicts with his wife, who did not share his convictions. He strove to simplify his own life, did manual work, ceased to use alcohol and tobacco, and became a vegetarian. In 1891 he gave his wife the copyright of all his works written before 1881 and of *The Death of Ivan Ilyich;* other works written after 1881 became free to all. He also divided his property, valued at about $290,000, among his wife and children, henceforth living on charity in his wife's or his son's house. In 1892, despite his reluctance to use money, he conducted effective famine relief in central Russia. Becoming interested in the Dukhobors, peasant sectarians who refused military service, in 1899 he completed *Resurrection,* his last novel, in order to raise the funds that would help them leave Russia. Written partly in his earlier manner, it contains magnificent scenes, but at the close degenerates into propaganda. In 1901 the Russian Orthodox Church issued a notice denouncing Tolstoy as a false teacher, but he had become world-famous and had more readers than any other writer had ever reached during his lifetime.

During his last ten years Tolstoy wrote only short pieces. The friction which had existed between himself and his wife for some time now increased. On Nov. 11, 1910, he fled from home, accompanied only by his daughter Alexandra. He was stricken with illness on the train and paused at Astapovo, a small station, where he died on November 21. *See also* ANNA KARENINA; KREUTZER SONATA, THE; WAR AND PEACE. G. R. N.

**TOLTEC** [tɒ'ltɛk], a term generally used to refer to the great native American civilization that flourished in the Valley of Mexico between A.D. 500 and 1100. During this period the spectacular ceremonial site of Teotihuacán was constructed, a vast area 3½ mi. by 2 mi. in extent, and given over to pyramids and temples. Toltec means "master builder," or, in effect, "civilized," and the succeeding warring tribes of the Valley of Mexico, between A.D. 1100 and 1300 referred to themselves by this designation. The two periods are often differentiated as Classical Toltec (the earlier builders of Teotihuacán) and "New" or "Dynastic" Toltec (following the downfall of Teotihuacán). The later Toltecs reputedly had their capital at Tula, also in the Valley of Mexico. *See also* ARCHAEOLOGY (*Middle America*). G. R. W.

**TOLUCA** [tolu'kɑ], the capital of the state of Mexico, in the south central part of the Mexican republic. An important commercial and crafts center, it is famous for basketry, natural-color wool blankets, and embroidered garments. The public library, on the main plaza, contains many rare volumes, and the state museum has archaeological, colonial, and modern exhibits. Toluca was founded by Hernando Cortes in 1533. Pop. 1950, 52,968. S. G. I.

**TOMATILLO** [to'mɑti'yo], a smooth annual, *Physalis ixocarpa,* of the nightshade family, having bright yellow flowers spotted with brown in the center. This plant, sometimes called the strawberry tomato, has oblong, thin, notched or toothed leaves, which are borne on the erect (4 ft.), branching stem. The purplish berry, which is round and large, completely fills the purple-veined, husklike calyx. The tomatillo is often cultivated for its edible fruit; although a native of Mexico, it has been naturalized in the warmer parts of the United States. M. G. W.

**TOMATO,** a tropical herb, *Lycopersicon esculentum,* of the nightshade family native to South America. In its native habitat the tomato is a perennial; in temperate climates it is grown as an annual. The plant, 6 ft. or more in height, bears yellow flowers and red or yellow fruit usually flattened at the ends, with the sides grooved or furrowed. It was introduced from Africa into cultivation during the sixteenth century, but was grown only as a curiosity. In the middle of the nineteenth century there were decided improvements in the size and form of the fruit, and since that time plant breeders have developed hundreds of varieties from the original small, wrinkled, seedy fruit. Tomato seed is started under glass for the purpose of producing early fruit and prolonging the bearing season. Seedlings are transplanted to shallow boxes, and from these to the open ground. The plants should be set in rows 4 or 5 ft. apart to permit cultivation. In home gardens and in commercial plantings in some regions, tomato plants are pruned and tied to stakes or wire trellises. V. A. T.

**TOMATO WORM,** the common name of the larva of *Protoparce quinquemaculata,* a gray hawk moth with blackish and whitish linear markings and five pairs of yellow spots on the sides of the abdomen. It is closely related to the tobacco worm; it may also attack tobacco, as well as tomatoes and other related plants. The eggs are laid singly, and since the caterpillars feed on the new growth, an individual larva may greatly reduce the yield of a plant. When very numerous, they may destroy a whole field of plants in little more than a week. C. H. Cu.

**TOMBIGBEE RIVER** [tɒmbɪ'gbi], 409 mi. long, in Mississippi and Alabama. The headwater streams, the West Fork and East Fork, rise in Union and Prentiss counties, Miss., and flow southward to join in Monroe Co. to form the Tombigbee. The river flows generally southeast, receiving the Buttahatchie and Luxapalila rivers. South of Columbus, Miss., it crosses into western Alabama, where it is joined by the Sipsey, Noxubee, Black Warrior (the major tributary), and Sucarnoochee rivers. About 40 mi. north of Mobile Bay it joins the Alabama River to form Mobile River, flowing into Mobile Bay at Mobile. The river has been improved for small-boat navigation for 149 mi., as far as Columbus, Miss. Timber, cotton, sand, and gravel are transported on the Tombigbee. The river was important in the early history of the region. Hernando de Soto in 1540 discovered the Tombigbee, and prior to 1825 settlements were developed along it. Part of the Tombigbee River flows through the fertile Black Prairie region, a great cotton-growing area. J. E. F.

**TOM BROWN'S SCHOOL DAYS,** a novel by Thomas Hughes, published in 1857. The book is autobiographical, being based on Hughes's experiences at Rugby School under the famous headmaster, Dr. Thomas Arnold. It was largely responsible for popularizing Arnold's system of education, with emphasis on the character-building value of sports, the importance of religious ideals, and the leadership of the older boys. Later it came to be considered sentimental for its omission of coarser elements. A sequel, *Tom Brown at Oxford,* was published serially in 1859-1860. L. St.

**TOMCOD,** *Microgadus tomcod,* a small fish of the cod family, the Gadidae. It greatly resembles the cod but may be distinguished by the narrow, elongated ventral fin. Tomcod occur in North American coastal waters from Labrador to Virginia and often enter the mouths of rivers and estuaries. Maximum length is about 14 in. but most are only 9 to 12 in. Tomcod feed on crustaceans, mollusks, squid, and small fishes which they find on the bottom. The eggs, unlike those of its larger relatives, are heavy and sink to the bottom. Some of them are caught commercially and marketed as table fish. Fisherman angle for them from docks and bridges even in New York harbor. E. C. R.

**TOM JONES.** *See* History of Tom Jones, a Foundling, The.

**TOM SAWYER, THE ADVENTURES OF,** a novel, published in 1876, by Samuel Langhorne Clemens (Mark Twain). It has been long acclaimed a classic of boyhood adventure but is better remembered for its incidents than for its plot. Tom's ingenious method of getting his friends to whitewash his fence, his schoolboy misdemeanors, the scene in the graveyard at midnight when he and his boon companion, Huckleberry Finn, witness a brutal killing, certain episodes on the Mississippi River, and the wanderings of Tom and his sweetheart, Becky Thatcher, lost for several days in a cave, are all more sharply in focus than the plot of murder and detection on which the incidents are loosely strung. Critics sometimes decry the book as inferior to its sequel, *The Adventures of Huckleberry Finn* (1884), though they grant that it is superior to the even less skilfully devised *Tom Sawyer Abroad* (1894) and *Tom Sawyer, Detective* (1896), but boys of all ages continue to find it a favorite. L. L.

**TOMSK** [tɔ′msk], a region of the Russian Soviet Federated Socialist Republic, in the Soviet Union, and its chief city.

**The City.** The city is about 123 mi. northwest of Novosibirsk, at 56° 30′ N. lat., 85° 12′ E. long. It lies astride the mouth of the Ushaika River on the eastern bank of the Tom, 27 mi. above its confluence with the Ob. Founded in 1604, it remained a small trading village until gold was discovered nearby in 1824. Within seventy-five years it became the largest city in Siberia. Exhaustion of the gold deposits and construction of the Trans-Siberian Railway 54 mi. to the south caused the town to lose much of its importance. The university, founded in 1888, made Tomsk an intellectual center and was the only university in northern Asia until 1918. There are also schools of technology, chemistry, and medicine located in the city. Tomsk is on a branch line from the Trans-Siberian Railway, and it has a small river port. Trade is extensive in grain, cattle, butter, fish, and timber, and manufactures include flour, aircraft engines, metal products, and leather. Pop. (est. 1950), 175,000. C. C. H.

**The Region.** The region lies in the central part of the R.S.F.S.R. and is bounded on the north and northwest by the Khanty-Mansiisk National Okrug, on the east by the Krasnoyarsk Region, on the south by the Kemerovo and Novosibirsk regions, and on the west by the Omsk region. Its 121,351 sq. mi. lie in the southern part of the West Siberian Lowland and are drained by tributaries of the Ob River, including the Tom, Ket, Chulym, and Vasyugan rivers. Small groups of Khantes, Manses, and Nenetses fish and hunt in the thick forests of the north. Near the city of Tomsk the forests begin to give way to a steppe on which are concentrated the Russians and Ukrainians, who account for nine tenths of the population. The cultivation of wheat, potatoes, and sugar beets and the breeding of cattle are important. Pop. (est. 1954), 750,000. D. L.

**TOM-TOM,** an onomatopoetic term for primitive (especially Amerindian) drums or their imitations. Written *tam-tam,* the term denotes the Far Eastern gong used in European music. W. Li.

**TONALITY,** the impression of key made upon the ear by a piece of music. When the harmony student is told that he should establish his tonality, the meaning is that he should make clear, chiefly by dominant and tonic chords, what the key is, before modulating or using chromatic progressions. The key signature gives visible evidence of the key, but the listener needs further assistance. Similarly, when tonality is said to be vague, the meaning may be that rival keys are asserting their claims, as in the exposition of a fugue, where the dominant key occurs as often as the tonic; or the meaning may be that no tonal center has been definitely "established."

Bitonality, as applied to twentieth century music, means the employment of two keys simultaneously, rather than the recognition by the ear of two keys, although such recognition is often possible. Polytonality, the use of more than two keys at once, is, from the listener's viewpoint, little different from atonality, the abolition of any tonal center. J. M. Ba.

**TONAWANDA** [tɒnəwɒ′ndə], a lake port city in western New York, in Erie Co., situated on the Niagara River, at the western terminus of the New York State Barge Canal, 9½ mi. north of Buffalo. The Erie and Iroquois Indians had precolonial settlements on the site. The first white settlers arrived in 1808, and the town of Tonawanda was formed in 1836 by the state legislature. Incorporated as a city in 1903. Tonawanda is governed by a mayor and city council. In its early days the community was considered one of the largest lumber centers in the country. Tonawanda's harbor is second in the state of the lake ports in the receipt of goods but not second in shipping. Abundant hydroelectric power for manufacturing is supplied by Niagara Falls; and Tonawanda and North Tonawanda, across the canal, form one industrial community. The city's leading manufactures are fiber, office equipment, steel, chains, paper, abrasives, paints, and roofing materials. Transportation is furnished by lake, canal, and river craft and by the International and the New York Central railroads. Pop. 1950, 14,617.

**TONE,** a term in music which has several meanings. In general it refers to a single sound of distinguishable pitch and definite duration, as opposed to noise and to a sequence of tones indistinguishable in pitch, such as a trombone "smear." Tones are thus the basic element in all music, although noise plays a minor role through rattles, clappers, and numerous other instruments of indefinite pitch. The British term for tone in this sense is "note."

In Great Britain and the United States the interval of a major second is also called a "tone" or "whole tone," while a minor second is a "semitone." In a third nontechnical sense, "tone" is musical sound in general, as in "tone poem," and "tone color." In Gregorian chant, a tone is one of a number of standard melodic formulae, to which psalms and other liturgical texts are sung. W. Li.

**TONE POEM.** *See* Symphonic Poem.

**TONGA.** *See* African Peoples.

**TONGA, or FRIENDLY, ISLANDS** [tɒ′ŋgə], a cluster of about 180 small tropical islands and islets in the south Pacific Ocean at 20° S. lat., and 175° W. long., east of the Fiji Islands, ethnographically included in Polynesia. The islands are dispersed through about 200 mi. of ocean, and have a total land area of approximately 250 sq. mi. They are divided into three main groups: Tongatabu, Vavau, and Haabai, with Niuafoo and Niuatobutabu isolated toward the north. The largest and most important island is Tongatabu, which occupies more than half the total land area of the cluster, and on which is located the capital, Nukualofa. The average annual temperature ranges from 73° F. to 76° F.; the average annual rainfall is from 78 to 88 in. Most of the inhabitants are engaged in agriculture. The principal export is copra, but bananas, citrus fruits, pineapples, yams, and other subsistence crops are grown in addition to coconuts. The islands were discovered by Dutch navigators in 1616 and visited by Abel Tasman in 1643 and by Captain Cook in 1773 and 1777. The present royal dynasty took power in 1845 and survived the assumption of British protection in 1900; it is the only remaining Polynesian kingdom. The courts of Tonga have jurisdiction over all but the more serious crimes of non native residents. The legislative function is in the hands of a parliament of 22 members comprising a speaker and three equal groups, one group named by the British Crown, one elected by the islands' nobility, and one elected by the commoners of Tonga. Pop., about 50,000. R. G. B.

**TONGUE.** *See* COMPARATIVE ANATOMY; SENSATION.

**TONGUE WORMS,** endoparasitic, blood-sucking forms of the class Pentastomida, in the phylum Arthropoda. They are closely related to the Acarina, the mites, a fact based on the mitelike appearance of the larva. The life cycle involves two hosts. In the family Porocephalidae (e.g. *Armillifer armilliatus* and *A. moniliformis*), the screw-shaped adults live in the lungs of reptiles, while the larvae inhabit the internal organs of a variety of vertebrates, including man. In the family Linguatulidae (e.g. *Linguatula serrata*), the tongue-shaped adults live in the nasal passages of dogs and cats. The larvae live in the organs of man and other mammals; these mammals, therefore, are the intermediate hosts and are infected by the ingestion of eggs that are in the soil. The eggs develop into larvae, which migrate to the organs and there encapsulate. The infective stage is called the nymph and it leaves the body only at the death of the intermediate host. These are then picked up by the definitive hosts, cat and dog. R. F. N.

**TONKA BEAN** [tɒ′ŋkə], a large tree, *Dipteryx odorata,* 60 to 80 ft. high, which is a member of the pea family and a native of Guiana. This tree bears an almondlike fruit which contains a long seed covered with a shiny black skin. The seed is known as the tonka bean and has an odor, due to the presence of coumarin, resembling that of new-mown hay. It is widely used in the manufacture of perfumes. M. G. W.

**TONKIN or TONKING** [tɒ′nkɪ′n, tɒ′ŋkɪ′ŋ], a former French protectorate in Indochina which in 1949 became a province, with the name of North Vietnam, of the new state of Vietnam. It has an area of 44,672 sq. mi. and consists of the valley and delta of the Yuan Kiang or Red River. It is bounded on the north by China, on the east by the Gulf of Tonkin, on the south by Annam and Laos, and on the west by Laos.

**Geography.** Mountainous areas border the alluvial plain of the Red River on three sides. The river, rising in China's Yünnan Province, crosses the territory from northwest to southeast and is joined above Hanoi by two important tributaries, the Claire River, and the Noire or Black River. A parallel mountain range traversing a large part of Tonkin separates the valleys of the Red and Black rivers. The soil in the valleys and delta is very fertile and is particularly suitable for rice production. Tonkin's climate is subtropical, with fairly cool weather in the winter and a short dry period.

**Ethnology and Population.** Tonkin had a population of 9,920,000 in 1942. Because of unsettled conditions and almost continuous warfare in the area since that date, its present population can only be conjectured. The population is very dense in the Red River delta area, reaching as high as 6,000 persons per square mile of cultivated area. The great majority of the inhabitants are Annamese, who are a mixture of the indigenous Indonesians and the Mongolian tribes originating in Tibet or southwestern China, with the addition of considerable Chinese blood. In the mountains are found a number of Thais and Indonesians. There are about 40,000 Chinese and about 20,000 Eurasians in Tonkin. Hanoi and Haiphong, which together form a major port, had a combined population of more than 343,000 in 1951. Buddhism, influenced by Confucianism and Taoism, is the predominant religion in Tonkin.

**Economic Life.** Rice is the major crop in Tonkin, production in 1944 having totaled 1,696,000 tons. Other products are corn, arrowroot, sugar cane, tea, fruits, tobacco, and raw silk. Tin, iron, and coal are mined, the latter two providing the territory's chief exports. There also are limestone quarries and deposits of calamine. These, with the presence of numerous rivers suitable for the production of hydroelectric power, provide the area with the potentialities of modern industrial development.

**History.** After 1,200 years of domination, the Annamese people threw off the Chinese yoke in A.D. 931. Thereafter, Tonkin was an independent state until 1802, when it became a province of Annam. In the latter part of the nineteenth century the French, desiring to obtain a means of access into southern China, were attracted to the Red River valley. They met considerable resistance, but by treaties in 1884 and 1885 with Tu Duc, the emperor of Annam, they acquired a protectorate over Tonkin, and in 1886 the territory was made a member of the French Indochinese Union. In 1897 the viceroyalty maintained in Tonkin by the emperor of Annam was superseded by a French residency administration.

Under this system, Tonkin was divided into twenty-three provinces, each administered by a resident under the general direction of a resident superior, assisted by an advisory council; he was responsible to the governor general of the French Indochinese Union. A native administration, subordinate to the French, was maintained.

During World War II, Tonkin, with the rest of Indochina, was occupied by the Japanese. At the time of the Japanese surrender, Tonkin fell under the control of the Viet Minh, the popular name for a revolutionary movement that had been developing for a number of years under the leadership of the Communist Ho Chi Minh, who in 1945 proclaimed the Democratic Republic of Vietnam, claiming jurisdiction over Tonkin, Annam, and Cochin China.

Negotiations between France and Ho Chi Minh, which for a while looked as though they might succeed, broke down in the latter part of 1946 and Tonkin became the center of bitter fighting between French and Viet Minh forces. The French reoccupied Hanoi and the Viet Minh forces

took to the mountains surrounding the Red River delta and valley. In 1949 Tonkin officially became the northern province of Vietnam under Chief of State Bao Dai. At the end of hostilities in July 1954, French Union forces still held Hanoi and much of the Red River Delta, but by the terms of the Geneva truce, all Vietnam north of parallel 17° N. was assigned to the Viet Minh pending a general election to be held in 1956; Tonkin thus became subject to the Viet Minh during that period. *See also* INDONESIA; VIETNAM.

A. V.

**TONLE SAP** [tɒ′nle sæ′p], a large lake in central Cambodia, Indochina. It is about 81 mi. long from northwest to southeast and is connected with the lower Mekong River by a canal and a small river. The lake acts as a reservoir for flood water from the Mekong during the summer wet season. The river backs up and flows into Tonle Sap, which expands to cover an area of about 2,300 sq. mi. and reaches a depth of about 30 ft. During the drier season in the winter Tonle Sap is reduced to about 518 sq. mi., the river reversing direction and draining the lake. During this period the lake resembles a large swamp, and even sampans have difficulty in crossing it because of mud. As the water recedes, it leaves a sediment which insures a rich rice crop, thus making the lake economically important. Fish are caught in large quantities.

J. E. F.

**TONO-BUNGAY** [to′no bʌ′ŋge], a humorously satiric novel by H. G. Wells, first published in 1909. The story is basically the history of the rise and final failure of a gigantic business based on the manufacture and sale of Tono-Bungay, a patent medicine, that brought for a time wealth, influence, respect, and the confidence of endless people to its inventor, Edward Ponderevo, and his nephew George. In the book Wells devotes considerable space to exposing certain sharp and dishonest practices then prevalent in the commercial and advertising fields.

N. MacM.

**TONSIL,** or palatine tonsil, one of a pair of oval masses of lymphoid tissue which lie in a depression between the soft palate and the tongue. The palatine tonsils, along with the pharyngeal tonsils or adenoids located in the roof of the pharynx, and the lingual tonsils located in the base of the tongue, form the tonsillar ring. The tonsils are not known to have any definite function, but their enlargement interferes seriously with breathing. *See also* RESPIRATORY DISEASES (*The Throat*).

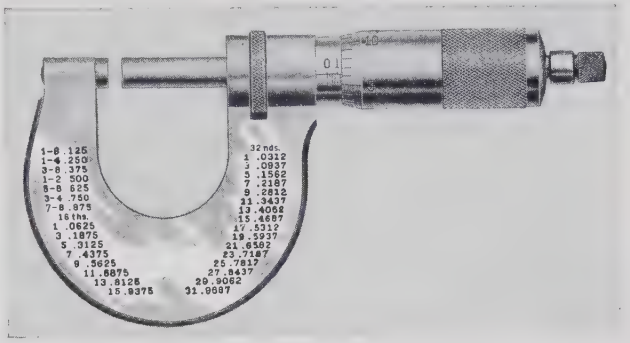
C. R. No.

**TONTO.** *See* INDIAN TRIBES, NORTH AMERICAN (*Southwest*).

**TOOELE** [tʊe′lɛ], a city in northern Utah, the county seat of Tooele Co., 24 mi. southwest of Salt Lake City. Tooele was founded in 1849 and incorporated in 1853; it has the council-manager form of government. The smelting of the lead, copper, and gold mined in the district is the city's leading industry. There are large salt deposits in the region. Scenic features include Great Salt Lake, about 10 mi. north, and Great Salt Lake Desert, about 45 mi. west. Pop. 1950, 7,269.

**TOOLS, GAUGING,** special devices employed for accurate measurements. Among such devices are: calipers, depth gauges, taper and thickness gauges, dial and surface gauges, spirit levels and plumb bobs, and straightedges and squares.

**Calipers and Depth Gauges.** There are certain commonly measured dimensions to which simple rules and scales are not applicable, such as diameters of cylinders, and diameters and depths of holes. Plain calipers and depth gauges may be set the size of the diameter or depth of hole and the "set" distance then measured by rule or scale. For greater accuracy in making such a measurement, direct-reading calipers of both the micrometer and vernier types are used. The micrometer principle is based on the great accuracy of a fine screw-thread. Reading a micrometer is a matter of counting the revolutions and fractions of revolutions of




COURTESY OF L. S. STARRETT CO.

*MICROMETER CALIPER*

*The setting shown is read as follows: 0.1 + 0.025 + 0.006 (approx.) = 0.131 (approx.). (Note: Gap between edges of caliper is less than this reading because of photographic reduction.)*

a thimble, as measured from a zero position. Whole revolutions are indicated by marks along the stationary sleeve, and partial revolutions by the graduations around the periphery of the rotating thimble. The screw that is used in most micrometers has 40 threads per inch and the thimble has 25 divisions around it, so that each division on the thimble represents one one-thousandth of an inch of motion of the spindle.

The vernier caliper is arranged to measure diameters directly in thousandths of inches. The main stationary scale has 50 graduations per inch, whereas the vernier has a total of 20 graduations. The 20 equal divisions of the vernier scale have the same total length as 19 of the divisions on the main scale. Thus, whenever the zero mark of the vernier stops between marks on the main scale, there can be only one of the vernier marks exactly opposite a mark on the main scale, and the number of this mark gives the number of twentieths by which the zero of the vernier scale has advanced from one main scale mark toward the next. The diameters may thus be read in thousandths of an inch.

**Taper and Thickness Gauges.** When very small distances are to be measured, of the order of a few thicknesses of paper, taper and thickness gauges are often used. The thickness gauge is used on a "go" and "no-go" basis. Different leaves of the thickness gauge are tried successively in the gap until one is found that will just slip into the gap, whereas the next one, greater by one thousandth of an inch, will not go into the gap. The taper gauge is utilized by slipping it into the gap and then sliding it toward the thicker end. By this means, the thickness of the taper at the point where it just enters the gap may then be read on the face of the taper gauge.

**Dial and Surface Gauges.** It is often important to know the amount of eccentricity of a supposedly true or concentric rotating shaft. The dial and surface gauges are used for this purpose. The dial gauge is supported with the plunger resting on the surface of the shaft to be tested. As the shaft is rotated, the plunger, pressed against the shaft

with a spring, rises or falls as the shaft wobbles. The motion of the plunger is multiplied by a lever system in the gauge and rotates a hand past a fixed dial. Dial gauges are made to indicate thousandths and ten-thousandths of inches.

**Spirit Levels and Plumb Bobs.** In building structures and setting up machinery, it is customary to set the main axes or planes parallel with the direction of the force of gravity or perpendicular thereto. The two devices ordinarily used to determine such parallelism are the spirit level and the plumb bob.

The plumb bob consists of a heavy weight suspended on a string. By suspending the plumb bob near to any supposed vertical number of a structure, the direction of the edge of the structure can be compared visually relative to the string. The accuracy of this method depends on the symmetry of the weight with respect to its point of attachment to the string.

The spirit level consists of a straightedge upon which a level vial is mounted. The level vial is a sealed glass tube a few inches long, filled with alcohol and containing a single bubble of air or other gas. When the vial is horizontal, this bubble finds a marked position on the tube. Thus, the straightedge may be laid on a workpiece and the latter adjusted until the level bubble is centered. By placing the level vial with its axis perpendicular to the straightedge, the straightedge may be used for checking vertical workpieces.

**Straightedges and Squares.** The laying out of work is customarily done with straightedges and squares. The majority of squares have angles of 90 deg. between the blades and the handles, although miter squares have 45 deg. angles. When angles other than these standard values are to be used, bevel protractors or bevels are used, in which the angle of the square is adjustable. *See also* MACHINE TOOLS.

E. D. H.

**TOOTHED HERRING.** *See* MOONEYE.

**TOOTHWORT,** common name of a genus, *Dentaria,* of small perennial herbs, growing to about 1½ ft. tall, of the mustard family. Among the best-known species are the milkmaids or western toothwort, *D. integrifolia,* native to the Pacific coast; the cut-leaved toothwort, *D. laciniata;* and the two-leaved toothwort, *D. diphylla,* which is also called crinkleroot and was used for food by the Iroquois and other Indian tribes. The flowers of these herbs are borne in small clusters and are white, purple, or rose-colored; the leaves are palmately divided, and the rootstocks are fleshy and horizontal. In Great Britain, a plant of the broomrape family, *Lathraea squamaria,* is known as toothwort. It is leafless, has rose-colored flowers, and is parasitic on the roots of trees.

M. G. W.

**TOOWOOMBA** [təwʊ′mbə], a city in the southeastern part of Queensland, eastern Australia, situated at 27° 44′ S. lat. and 152° 0′ E. long. in Aubengy Co. It is about 70 mi. west of Brisbane and is in Craig's Range, which has an elevation of 2,000-3,000 ft. above sea level. It is also within the Australian humid subtropical belt, but its climate is modified by elevation.

Toowoomba is known as "The Garden City of Queensland," but it is also an industrial center, with lumber and steel mills, soap factories, and tanning and leather industries. It has long been famous as a summer resort. The city was chartered as a municipality in 1860 and is an important railway terminus. It has many parks, churches, and fine buildings, and is the seat of the Christian Brothers College. Pop. 1947, 33,326.

J. E. F.

**TOPAZ** [to′pæz], a mineral with both gem and industrial uses. It is an aluminum fluosilicate, $Al_2SiO_4(F,OH)_2$. Topaz occurs either in well developed prismatic orthorhombic crystals or in large formless masses. It has a hardness of 8, and one direction (basal) of perfect cleavage. Topaz is typically associated with granite or its volcanic equivalent, rhyolite. It occurs in granite pegmatites and in cavities in rhyolite. It is also found as an abundant gangue mineral in tin-bearing high-temperature hydrothermal veins. In addition to its use as a precious stone, topaz is mined and used as a substitute for fluorspar in steel making and for leadless glazes in ceramics. It also has possibilities as a substitute for kyanite in refractories. Commercial deposits of massive topaz have been developed near Kershaw, S. C., and in Gunnison Co., Colo.

Pale yellow to yellow-brown or blue are colors usually associated with gem topaz. However, colorless, green and sometimes pink topaz is found in nature. Yellow topaz from Brazil, subjected to heat, turns pink upon cooling. Not all yellow topaz is so affected by heat, however, and some even loses its color upon being subjected to sunlight for any length of time. Precious topaz of fine quality is a relatively rare mineral. The confusion which exists between the heat-treated mineral known as "topaz-quartz" and precious topaz is discussed under quartz. Occasionally, very large crystals of precious topaz weighing several pounds have been found in the Minas Gerais province of Brazil. Both the Ural and Ilmen mountains produce fine topaz. Ceylon, Burma, Japan, Madagascar, New South Wales, and Germany are other sources of the mineral.

In commerce, topaz has suffered under a variety of confusing prefixes and terms: "Oriental," "Occidental," "Spanish," "Brazilian," "Indian," to name a few. Unfortunately some of these names are applied to yellow sapphire or yellow quartz, both inferior gems which have been called some form of topaz so that higher prices can be asked.

A synthetic spinel is now marketed which has the identical hue of precious blue topaz. By use of a special absorption filter, the "blue" of the synthetic turns red, disclosing the imitation from the real. Other physical characteristics further aid in making differentiation possible.

K. K. L.

**TOPE.** *See* STUPA.

**TOPEKA** [topi′kə], the capital city of Kansas, the county seat of Shawnee Co., in the northeastern part of the state, about 60 mi. west of Kansas City. In their search for gold in the sixteenth century the Spanish explorers visited the region, but it was not until the California gold rush that there was continuous white settlement in the area. In 1854 the Federal Government opened up the territory for settlement, and in December of that year the site of Topeka was staked off. The first settlers were antislavery men, and the community, which was incorporated in 1857, became the center for the free-soil legislation. In 1855 the famous Topeka Constitution was framed. When Kansas was admitted to the Union as a state in 1861, Topeka became the capital. In 1863 it was the starting point for the construction of the railroad which was to become the Atchison, Topeka and Santa Fe. This line has continuously maintained in Topeka its main offices, largest railroad shops, and a hospital for its employees.

The city's educational institutions include the Washburn Municipal University, Kansas Vocational School for Negroes, and State Industrial School for Boys. Located in Topeka are Menninger Foundation, the noted psychiatric clinic, and a

state hospital for the insane. Cultural and recreational facilities are found at the Mulvane Art Museum, the state historical society museum, the municipal auditorium, Gage Park with the Reinisch Rose and Rock Garden, Lake Shawnee Park with a 400-acre lake, and the Kansas Free Fair Grounds.

In addition to the Santa Fe, transportation facilities are provided by the Chicago, Rock Island & Pacific, Missouri Pacific, and Union Pacific railroads, and by the Braniff, Continental, and Trans World air lines. The city's location between the corn belt and cattle-breeding districts of the Southwest and the winter-wheat fields and chief markets of the country has made Topeka an important shipping and distribution point. Agriculture is the basis for the city's main industries: the processing and packing of meat and food products and flour milling. Railroading, printing and publishing, and metal working are also important, and the output of the other varied industries include tires, lime, steel, medicines, and serums. Pop. 1950, 78,791. S. D. M.

**TOPOLOGY** [topɒ'ləji], that branch of geometry which investigates the form and position of geometrical objects. It is sometimes called analysis situs (analysis of situation) or point-set theory. Here the phrase "form and position" is used in its widest sense and carries no implication of metric or measurable properties. Thus topology is qualitative and descriptive. It is popularly called "rubber-sheet" geometry since it ignores changes that are caused by continuous distortion and stretching.

There are three main branches of topology: point-set theoretic, algebraic, and mapping. Though some of the concepts are of earlier origin, it is safe to make the general statement that these fields were initiated by Georg Cantor (1845-1918), Henri Poincaré (1854-1912), and L. E. J. Brouwer (1882- ). Tremendous changes in mathematical thought and technique have taken place since the appearance of Cantor's first paper on set theory and have led to investigations of the foundations of logic and mathematics.

**Closed, Open, and Connected Sets.** By a neighborhood of a point in space is meant the set of all points interior to a sphere with the given point as center. If $A$ is a subset of space (for example the set of points lying inside a cube), then a point $P$ is a limit point of $A$ if every neighborhood of $P$ contains a point of $A$. Thus, the boundary points of the cube are limit points of the interior points. If $P$ is a point distinct from the point $Q$, then $P$ is not a limit point of the set consisting of $Q$ alone. A set is said to be closed if it contains all of its limit points. Thus, a line is a closed set. A set is said to be open if it contains at least one neighborhood of each of its points. A line is not an open set, but the set of all points not lying on a given line is an open set. A set is said to be connected if, no matter how it is decomposed into two sets (each containing at least one point), one of these sets contains a limit point of the other. A plane is connected, but the set consisting of two parallel planes is not connected. Entirely analogous definitions may be phrased in the plane if, in the definition of "neighborhood," the word "sphere" is replaced by "circle."

Let $A$ and $B$ be two subsets of space. If to each point $P$ of $A$ there is assigned a point $Q$ of $B$ in a continuous way (or, expressed technically, so that limit points are preserved), then the assignment is called a map or a continuous correspondence. If also each point $Q$ of $B$ is assigned from one and only one point $P$ of $A$ and, further, if the reversal of this assignment is a map, then the sets $A$ and $B$ are said to be homeomorphic or topologically equivalent, and the map is called a homeomorphism. Topology is the study of properties left unchanged by homeomorphisms. Thus a sphere together with its interior is not to be distinguished topologically from a cube together with its interior. But a line and a plane are topologically distinct.

By a simple closed curve is meant a set homeomorphic with a circle (the periphery only). The Jordan closed-curve theorem states that a simple closed curve in the plane divides the plane into two sets which are open and connected, and that each point on the curve is a limit point of the two sets. Despite the deceptive simplicity of this result, its proof is by no means simple. A proposition of this sort is in the domain of point-set theoretic topology. Proofs, however, may be given by both algebraic and mapping theoretic means. The theorem can be extended to simple closed surfaces in space and, also, even to very irregular surfaces and curves. The statements of some of these generalizations can be given only in algebraic terms.

Let $A$ denote a sphere together with its interior. Then the Brouwer fixed-point theorem asserts that any map of $A$ into itself leaves at least one point fixed. This result is perhaps the most frequently applied theorem in other branches of mathematics.

Let $P$ denote some definite point of a connected set $A$ in space. A generic closed curve containing $P$ and lying in $A$ will be denoted by $C$. Each such curve is assigned a definite but arbitrary orientation or sense of traversal. The curves considered are not necessarily simple and so may have self-intersections, as a figure 8 curve. The product, $C \cdot C'$, of two curves $C$ and $C'$, is the curve obtained by first traversing $C'$ and then $C$. For each curve $C$ one writes $C^{-1}$ for the same curve as $C$ but with the opposite orientation. Two curves are said to be equivalent if it is possible to deform one into the other without leaving the set $A$, keeping the point $P$ fixed at all times. With the use of this multiplication, and the inverse, it is possible to regard the classes of equivalent curves as forming a group. With suitable hypotheses on the set $A$ it may be shown that any set homeomorphic with $A$ has the same group. The circle (periphery only) has for its group essentially the group of integers, and hence likewise does any simple closed curve. The group of the figure 8 curve is quite complicated, but the group of the line is simple, containing only the neutral element.

**Four-Color Problem.** One of the most interesting and still unsolved problems of topology is the four-color problem. It amounts merely to the question: Can any map be colored with four colors so that areas having a common boundary may have different colors? It is admissible, for example, to color Utah and New Mexico both blue and Colorado and Arizona both green since the common boundary of these states is a point. That this is a problem in topology is quite clear, since area has no bearing in the matter and the fact that a boundary line is straight or curved is of no importance. It may be shown that five colors suffice to color any map.

**One-sided Surface.** An interesting and instructive example is that of a one-sided surface. The simplest such surface may be constructed as follows: Let $ABCD$ denote the vertices of a rectangle (for convenience longer in the direction $BC$ than in the direction $AB$) named in clockwise direction. Give the rectangle a half twist and join the edges $AB$ and $CD$ so that $C$ falls on $A$ and $D$ on $B$. The surface thus obtained is called a Möbius band and is topologically distinct from the surface obtained by joining $AB$ and $CD$ without making a twist. A. D. W.

**TOPONYMY.** *See* PLACE NAMES.

**TOPSY,** a young Negro girl in Harriet Beecher Stowe's *Uncle Tom's Cabin* (1852). When questioned about her family, Topsy says: "Never was born, never had no father, nor mother, nor nothin' . . . I 'spect I growed." L. L.

**TORADJA.** *See* Indonesian Peoples (*Principal Peoples*).

**TORAH** [to′rɑ], a Hebrew word meaning "law" or "teaching." The term is primarily applied to the Pentateuch or Five Books of Moses, but sometimes to the entire body of Jewish law or to the entire Bible. *See also* Bible; Old Testament; Oral Law; Pentateuch; Talmud; *and individual articles on books of the Pentateuch.* D. G.

**TORDESILLAS, ANTONIO DE HERRERA Y.** *See* Herrera y Tordesillas, Antonio de.

**TORGAU** [tɔ′rgau], a town in the former Prussian province of Saxony, in eastern Germany, 31 mi. northeast of Leipzig, on the Elbe River. A tenth-century fortress town, it later belonged to the margraves of Meissen, then passed to Saxony. The Torgau articles were drawn up there by Martin Luther and his fellow Protestants. In 1760 Frederick the Great won a bloody victory over the Austrians in Torgau. The town became famous on Apr. 22, 1945, when American and Soviet troops joined forces at the Elbe and so split Germany north and south in the last days of World War II. By prior arrangement, American forces stopped at the Elbe-Mulde rivers and waited for the Russians to drive westward, while a small advance party entered Torgau to make the junction. At the conclusion of the war the town was included in the zone occupied by the Soviet Union. Pop. (est. 1938), 15,300. C. C. H.

**TORGUT.** *See* Asiatic Tribes (*Ural-Altaic*).
**TORII.** *See* Architectural Terms.
**TORNADO.** *See* Meteorology.

**TORNEÄLVEN** or **TORNE RIVER** [to′rnəælv, to′rnə], in northern Sweden, a part of the boundary between that country and Finland to the east. Rising at the southeastern extremity of Lake Torneträsk in the Kjölen Mountains near the Norwegian border, the Torne flows southeast for about 130 mi. to a point below Pajala, where the Muonio joins it. Here the Torne turns south for about 125 mi., widening considerably and becoming less swift, to flow into the Gulf of Bothnia at the twin ports of Haparanda, Sweden, and Tornio, Finland. It drains 15,400 sq. mi.—9,650 in Sweden and 5,750 in Finland. Its main tributaries are the Rautasjoki, on the right bank, and the Lainio and the Muonio, on the left. The Muonio from its confluence with the Torne forms the international boundary extending northward for about 175 mi. to its headwaters at Lake Kilpisjärvi, where Norway, Sweden, and Finland meet. Besides Haparanda and Tornio, the only river towns having a population of more than 1,000 in 1947 were Kiruna, Vittangi, and Pajala. As a boundary river, the Torne is of considerable strategic importance, but it has little value for navigation. J. E. V.

**TORONTO** [tərɒ′nto], the capital and largest city of Ontario, and second largest city in Canada, situated on the northwestern shore of Lake Ontario, 230 mi. southwest of Ottawa, and 228 mi. northeast of Detroit, Mich. Its harbor is one of the most important on the Great Lakes. Toronto is the focal point of the Ontario provincial highway system and is connected with Niagara Falls and Buffalo, N.Y., by the Queen Elizabeth Way. Transportation facilities are provided by the main lines and branches of the Canadian National and Canadian Pacific railroads, several steamship lines, and the American and Trans-Canada airlines.

**Physical Features.** The site of Toronto is determined by the presence of the harbor, a natural bay about 2 sq. mi. in area, protected from the open water of Lake Ontario by a curved sand bar about 4 mi. long known as Toronto Islands. Entrance to the harbor is through concrete line canals at both the eastern and western extremities. On the island are many summer cottages, parks, playgrounds, and an airport.

The city is built on a gently sloping plain which rises from the water's edge, which is 245 ft. above sea level, to a height of more than 600 ft. in the northern part of the city. The area within the city limits is about 35 sq. mi. The Humber River flows through the western part of the city, and the Don River flows through the eastern part. Both rivers and their tributaries flow in deep valleys, interrupting the rectangular street pattern and requiring a great number of bridges.

**History.** Toronto is a word of Huron origin signifying place of meeting. The area was visited by Etienne Brulé in 1615. A French trading post was established in 1720 but was abandoned in 1730. In 1750 a French trading post, Fort Rouillé, was founded, which in turn was abandoned in 1759 after the evacuation of the territory by the French. Under Governor John G. Simco the site was selected as the capital of Upper Canada in 1793 and the transfer of administration from Newark (Niagara-on-the-Lake) began in the summer of that year, continuing until 1796. A town was laid out in 1793 and called York. During the War of 1812 the government buildings were burned by invading United States forces. Incorporated as a town in 1817, the community became the city of Toronto in 1834 with a population of 9,254. Growing steadily after 1835, metropolitan Toronto had a population in 1951 of 1,117,470.

**Government.** The city is governed by a mayor, four controllers, and eighteen aldermen elected annually. The board of education is elected yearly, and the police, street, railway, hydroelectric services, and the harbor are administered by appointed commissions.

**Institutions and Buildings.** Toronto has many educational foundations, including both technical and commercial institutions, private schools, and colleges. The University of Toronto, located on a beautiful campus adjacent to Queen's Park, is the largest university in Canada. Affiliated with the University and also located in Toronto are Knox, Wycliffe, Trinity, and Emmanuel Theological colleges, the Ontario College of Pharmacy, the Ontario College of Art, and the Royal Conservatory of Music. Toronto is a noted medical center with ten large hospitals in 1947, the University of Toronto School of Hygiene, Connaught Laboratories, and Banting Institute.

The Royal Ontario Museum has collections in geology, zoology, and anthropology, and the most complete collections of Chinese art in North America. The Grange houses the Toronto Art Gallery, which has an extensive collection of Canadian art. The city has numerous beautiful churches and is the see of an Anglican and a Roman Catholic archbishop. Massey Hall and Maple Leaf Gardens are two large auditoriums. In 1952 Toronto claimed the largest hotel in the British domain, the Royal York, and the highest building in the Empire, the Canadian Bank of Commerce.

Of interest are the Canadian National Exhibition held near the site of Fort Rouillé every September and the annual No-

COURTESY OF CANADIAN NATIONAL RAILWAYS

*SKYLINE OF TORONTO ALONG LAKE ONTARIO*

vember Royal Winter Fair, at which are exhibited the best of Canada's livestock and agricultural products.

**Parks.** The park system, playgrounds, and squares in 1952 comprised 2,309 acres. Among the more notable are Queen's Park, covering 40 acres in the center of the city and containing the provincial parliament buildings; Riverdale Park with the zoo in the Don Valley; High Park in the western section of the city, a large natural area which has a small zoo and a pioneer exhibit housed in Colborne Lodge; and Exhibition Park, containing 350 acres, on the lake shore west of the harbor.

**Economic Activities.** Toronto is a busy commercial, industrial, and residential city. In 1952 it was the headquarters of four of the ten chartered banks in Canada. The Toronto Stock Exchange is the greatest market for mining shares in the world. As an industrial center, Toronto is second to Montreal in the Dominion. The rapid increase in industry in the area has necessitated the building of steam generated electric stations to augment the supply from Niagara. The chief products include foods and beverages, iron and steel products, clothing, chemical and allied products, and electrical apparatus and supplies. The city is one of the chief livestock markets in Canada, and through its port is shipped most of the meat sent to Great Britain. The city is considered Canada's publishing center. Pop. 1951, Greater Toronto, 1,117,470; Toronto proper, 675,754. D. F. P.

**TORONTO, UNIVERSITY OF,** the provincial university of Ontario, Canada. The nucleus of the university was King's College, a Church of England institution chartered in 1827 but not established until 1843. In 1850 it was reorganized and completely secularized. The university has faculties of arts, medicine, applied science and engineering, household science, education, forestry, music, graduate studies, and dentistry. There are schools of law, architecture, physical and health education, social work, nursing, hygiene, and Chinese studies, and institutes of child study and business administration. In the faculty of medicine is the Banting and Best Medical Research Department, commonly known as the Banting Institute. The Connaught Medical Research Laboratories are associated with the school of hygiene. The Royal Ontario Museum has become a part of the university, and the Royal Conservatory of Music is under university control.

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*Hart House, social center for men of the University of Toronto*

University College, which grew out of King's College, was founded in 1853. Other arts colleges in federation with the university, with the respective dates of founding and federation are: Victoria University, 1830 and 1890; University of Trinity College, 1851 and 1904; and St. Michael's College, 1852 and 1890. Closely connected with this last is the Pontifical Institute of Mediaeval Studies. Theology, as well as the arts, is taught in each of these three institutions. The theological faculty of Victoria University, known as Emmanuel College, operates under the United Church of Canada. Trinity and St. Michael's are respectively Anglican and Roman Catholic. Knox College (Presbyterian) and Wycliffe College (Anglican), which teach theology only, are also federated with the university. The various arts colleges limit their teaching to the humanities, principally languages, the university being responsible for the teaching of the natural and some of the social sciences. Other colleges in affiliation with the university are: Ontario Agricultural College and Ontario Veterinary College in Guelph; Ontario College of Pharmacy and Ontario College of Art in Toronto; and Albert College, Belleville. The Department of University Extension was organized in 1920. It conducts a summer school and evening courses leading to the B.A. degree. In the academic year 1949-1950 this department had an enrollment of over 10,000, of whom 1,195 were credit students. The enrollment in the regular full-time courses was 14,141.

The libraries of the university and its federated colleges in Toronto contain over 735,000 volumes. J. J. T.

**TORPEDO,** electric rays of the family Torpedinidae, having broad, disklike bodies and short, thick tails. A number of species are found, mostly near the shores in the warm seas. The electric organs, derived from muscular tissue, occupy an area at the base of both pectoral fins. Many hexagonal tubes filled with a gelatinous substance are divided into compartments each forming an electroplax. A main

nerve connects a special lobe of the brain with the small nerves of each plate. The torpedo uses its electric charge for protection and to stun or kill its prey. The shock of a large specimen can knock down a man. Repeated use weakens the shock although 150 shocks per second may be produced. The larger species range from 3 to 6 ft. long and weigh 200 lb. It lives sluggishly in the sand, sometimes partially buried. Young are born alive. E. C. R.

**TORPEDO,** a small, crewless undersea craft, self-propelled and self-steered in both azimuth and depth, carrying an explosive charge that is arranged to detonate in contact with, or in a certain proximity to, its target.

Until the latter part of the nineteenth century, the term torpedo seems to have been applied to any explosive charge, complete with detonating feature. It was prepared in advance and transported to the site of its intended use, where it might be hidden either on land or under water, or otherwise transported or propelled to explode upon contact with a solid object. The torpedoes damned by Farragut at Mobile Bay were such charges, encased in iron and strapped to the tops of submerged piles or, if buoyant, moored below the surface. They were usually detonated when contacted by a vessel, although sometimes they were fired, electrically or otherwise, from the shore. Such weapons would now be called mines.

In 1855, an inventor named White proposed to the United States Navy a small engine-driven boat with apparatus (not delineated) to steer a straight course to an enemy vessel, the boat to carry an explosive charge intended to be detonated on contact with the target. This plan attracted little official favor. In 1864, however, under the stimulus of the American Civil War, such a craft was actually demonstrated by Willoughby and Ramsey off Washington, D. C., in the Potomac River. A launch was powered by a petroleum-fired steam boiler and made an average speed of about 4 knots. It dragged two tiller lines behind it, the lines paying out from two drums on the shore. The application of a brake to either of these drums placed more pull on one tiller line than on the other and thus steered the launch much as a plow horse is guided.

The Whitehead torpedo, first tried out in 1868, is the prototype of all later torpedoes not electrically propelled. This torpedo, as accepted by the Austrian navy in 1868, was in two sizes, 14 in. dia. by 11½ ft. long, and 16 in. dia. by 14 ft. long. Both sizes ran 659 yd. at a speed of about 7 knots. The small size weighed 346 lb. and carried a charge of gun cotton. The larger size weighed 650 lb. and carried 60 lb. of gun cotton. A single screw was driven by a compressed-air engine. Horizontal steering was lacking. Vertical steering was accomplished by "The Secret," which is understood to have been similar in principle to more modern units, i.e., a hydrostat and pendulum both working upon a system of compound levers to operate rudders. Acceptance by the Austrian navy was followed successively in short order by Britain, France, Italy, and Germany; and later by practically all other countries, although the United States, shortly after 1900, went to the Bliss-Leavitt type, in which the same results are sought as in the Whitehead, but by the use of different mechanisms. Each country or firm licensing the Whitehead has varied or improved it according to its own ideas. The principal differences between the Whitehead and the Bliss-Leavitt types (1950) lie in the relative locations of compartments and mechanisms, and the use of turbines in the Bliss-Leavitt types instead of cylinder engines as in the Whitehead types.

Other forms of torpedo developed between 1867 and 1900, which have become obsolete, are described in the following.

**Towed Torpedoes.** Towed torpedoes were similar to the paravanes of World War I, but with additional means for steering and carrying explosive. Similar devices were used against submarines in World War I with little success.

**Projectile Torpedoes.** Projectile torpedoes were fired from an underwater gun with considerable velocity. They had no self-contained propulsion means.

**Rocket Torpedoes.** Most rocket torpedoes were very crude, but at least one had a system of duplex jets, one at the tail and one at the periphery just aft of the head (for better dynamic stability), and helical external vanes to impart spin. Failures were due to inefficacy of burning compounds and lack of means for steering.

**Gas-driven Torpedoes.** In gas-driven torpedoes, carbon dioxide or (in one case) ammonia, liquefied by pressure, vaporized and drove a cylinder engine or turbine.

**Locomotive Torpedoes.** Locomotive torpedoes embody a class so-called because they received power from an external source while running. One type was electric and another was operated by compressed air. A third type was driven by the unwinding of thin steel wires from drums within the torpedo onto large high-speed steam-engine-driven winches ashore. The drums within the torpedo drove propellers through gearing.

**Steam Torpedoes.** Steam torpedoes were charged with superheated water, under pressure, which generated steam as soon as the valve leading to the engine was opened. None got beyond the experimental stage.

**Inertia-drive Torpedoes.** Inertia-drive torpedoes involved a heavy flywheel, spun up to speed by external arrangements, energy being stored to drive propellers through gearing. The best development of this type, the *Howell,* was standard in the United States Navy from about 1890 to 1900. Its range and speed were somewhat less than the Whiteheads of that day, but this was considered compensated for by its inherent stability of direction, due to the gyroscopic effect of its flywheel. If the torpedo left its course, the gyro precessed, causing a list and a pendulum to swing, operating rudders to bring the torpedo back to course.

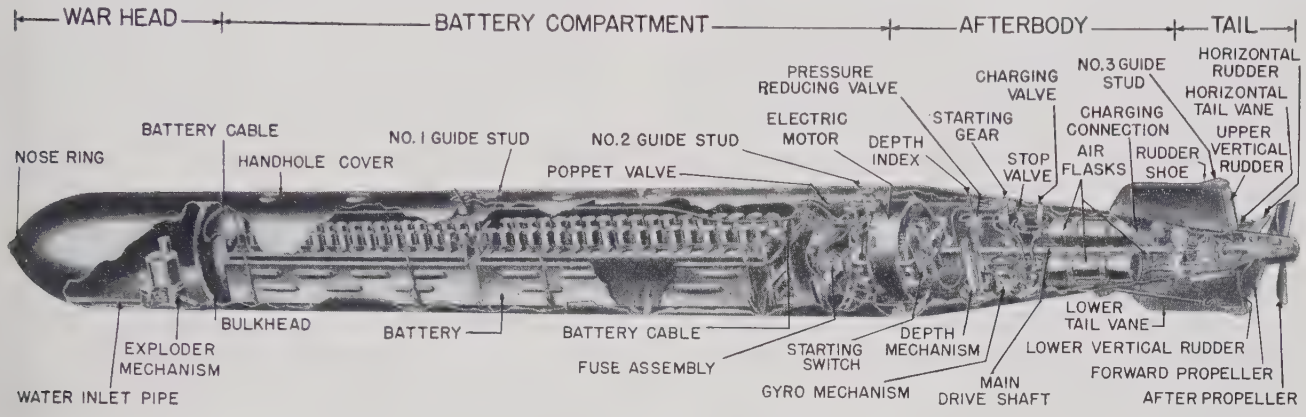
### BLISS-LEAVITT TORPEDOES

The United States Naval Torpedo Station, Newport, Rhode Island, commenced the manufacture of Bliss-Leavitt-type torpedoes in 1908, and has worked continuously upon their manufacture and improvement since.

**Arrangement.** In a typical United States Naval torpedo of 1940, the general arrangement of components is as follows; starting at the nose: (1) Head, containing explosive and explorer (or, for exercise shots, water, recording devices, and means for expelling the water at the end of the run); (2) Airflask, containing air at an initial pressure of about 200 atmospheres; (3) Fuel and Water compartments, with air connections to expel the liquids into the combustion pot; (4) Midship Section (open to sea), containing reducing valve for maintaining constant operating pressure of about 400 lb. per sq. in., combustion pot, valves and piping; (5) Afterbody, containing turbine and gear train, starting mechanism, steering controls and servos; and (6) Tail, containing mounting vanes, rudders and propellers.

**Aircraft Torpedoes.** Aircraft torpedoes underwent considerable improvement during World War II, particularly in the United States, which was already in possession of a torpedo which had been designed especially for aircraft drops

(in the matter of proportioning the shell for maximum beam strength, minimum air resistance and reasonable aerodynamic stability), while retaining good characteristics of water run. This torpedo had a slightly greater diameter than those intended for firing from ships and a considerably smaller ratio of length to diameter, and hence much greater beam strength. At the start of the war, it was considered that it should be dropped only between 30 and 75 ft. altitude, and from planes not making more than a little over 100 knots. Before the end of the war, however, the aircraft speed at which it was possible to successfully launch torpedoes had been more than doubled and the altitude of drop increased in even greater proportion.




U.S. NAVY PHOTO

*UNITED STATES NAVY ELECTRIC TORPEDO*

*Starting gear on top of afterbody is mechanically triggered as torpedo leaves its launching tube, opening air valves to: (1) spin gyro; (2) throw starting switch; and (3) turn air into steering servo motors. Torpedo proceeds to preset depth and course and, thereafter, is steered automatically: vertically, by a depth mechanism; and horizontally, by a gyro mechanism.*

**Electric Torpedoes.** Electric torpedoes have one great advantage in that no exhaust smoke or bubble trail shows; and one disadvantage (which under some circumstances is almost of equal importance), the relatively great weight per unit of energy of the conventional lead-acid storage battery. By reason of this weight, the comparison of a Bliss-Leavitt torpedo with an electric torpedo of the same outline, weight range, and explosive capacity indicates that the former provides almost three times as much work as the latter. Other means of producing electric power, having very much less weight per unit of energy, are well known but are prohibitive in cost except for special applications.

**Torpedo Exploders.** Torpedo exploders in early Whiteheads were mechanical triggering devices. Next, chronologically, came types which were actuated by the inertia of a relatively heavy part. Both of these exploded the torpedo on actual contact.

The Germans, in the latter part of World War I, had some success with an influence exploder which utilized a sensitive galvanometer registering changes in magnetic field, due to the proximity of a ship, and activating a relay firing system when such changes occurred.

**Target-seeking Torpedoes.** To John Hayes Hammond, Jr., is attributed the invention in the 1920's of a device which could be mounted in a torpedo and then would cause it to follow any target which came within its range of sensitivity. Target-seeking torpedoes were not used in combat until the latter half of World War II.

**Torpedo Launching.** From surface ships of any size, torpedoes are expelled from torpedo tubes by air pressure, or by the gas pressure generated by burning a small charge of powder. Torpedoes built for this service are launched without injury or perturbation of their controls from heights of about 25 ft. above the water from vessels traveling at 30 knots, or better.

In submarines, the conventional torpedo tube resembles an air-lock, having pressure-tight doors at both breech and muzzle. The muzzle door being secured and the tube drained of water, the breech door is opened and a torpedo loaded in. The breech door is then closed, the tube flooded, and the muzzle door opened. When ready to fire, a charge of compressed air, admitted near the breech, expels the torpedo. *See also* NAVAL MINES. J. M. St.

**TORPEDO BOAT.** *See* SHIPS, NAVAL (*Combatant Vessels; Patrol Vessels*).

**TORQUAY** [tɔrki′], a municipal and parliamentary borough, seaport, and resort in Devonshire, England, situated on terraced hills above Tor Bay on the English Channel, about 220 mi. southwest of London. It is known as the English Riviera. There are evidences of Roman, Celtic, Saxon, and Norman occupancy. The present town was founded in 1196, but its growth dates from the nineteenth century when it became popular as a resort. Torquay has figured in history as the spot where Don Pedro's galley was towed after the defeat of the Armada in 1588 and as the landing place of William of Orange in 1688. In World War II Torquay was bombed; the damage was extensive and many children were killed. Kent's Cave contains relics of great antiquity, and interesting buildings include ruins of twelfth-century Tor Abbey and the thirteenth-century "Spanish Barn" where Armada prisoners were held. Pop. 1954, 49,270. A. W.

**TORQUEMADA, TOMÁS DE** [tɔ′rkemɑ′ŧhɑ] (1420-1498), first Grand Inquistor of Spain, was born in 1420 at Valladolid, where he entered the Dominican monastery in early youth. He was later appointed Prior at Segovia, and in 1474, upon the accession of Isabella to the throne of Castile, became one of her most influential councilors but refused ecclesiastical honors. The Spanish Inquisition, established under Ferdinand and Isabella in 1478, was rapidly centralized by Torquemada after his appointment in 1483 as Grand Inquistor. He gained the reputation, partly deserved, partly exaggerated, of great cruelty in his conduct of the Spanish Inquisition, which, according to most historians, was responsible for the burning of some two thousand persons between

1481 and 1504; and he was chiefly instrumental in obtaining the expulsion of the Jews from Spain in 1492. He died at Avila, Sept. 16, 1498. *See also* INQUISITION, THE. W. C.

**TORRANCE** [tɒ′rəns], an industrial city in southern California, in Los Angeles Co., 16 mi. south of Los Angeles. The farmers in the district raise fruit and vegetables. Founded in 1911 by Jared Sidney Torrance and incorporated as a city in 1921, the community is governed by a council and manager. Torrance is the site of a county hospital. It has transportation facilities provided by the Pacific Electric, the Atchison, Topeka and Santa Fe, and the Southern Pacific railroads. Located in an oil region, Torrance has a large oil refinery. Other industrial establishments include iron and steel works, railroad shops, aircraft plants, and machine shops. The varied factory output includes synthetic rubber, plumbing supplies, tools, insulation products, oil machinery, and aluminum. Pop. 1950, 22,241.

**TORRENS SYSTEM** [tɒ′rənz], in law, a system or code of registration of title to real estate, originally adopted in South Australia in 1858 under the sponsorship of its premier, Sir Robert Richard Torrens, and subsequently enacted in other English dominions, in England, and in several states in the United States. New York has had a title registration code patterned on the Torrens systems since 1908. In the United States, title registration under Torrens system laws involves resort to a judicial proceeding and the determination of title therein; elsewhere the proceeding is conducted by administrative officers. H. Si.

**TORREÓN** [tɔ′rreɔ′n], a city in the state of Coahuila, northern Mexico, situated 500 mi. northwest of Mexico City. It is a railway junction, and the numerous mines in the district and various industries make it the most important commercial center in the state. New as Mexican cities go, Torreón is the setting of an interesting sociological experiment. In the 1930's one of the world's largest experiments in collective agriculture was undertaken at Torreón. An extensive tract of land was expropriated and 160,000 peasants were allotted acreage. A community of farms, residences, stores, schools, and recreation centers was built, and farming machinery was provided. Annual institutes, where visitors may study the project, are held. Torreón was made a city in 1907, and has arcaded shops, government buildings, hotels, banks, and churches. Pop. 1950, 128,976. S. G. I.

**TORRES STRAIT** [tɒ′rəs], a broad, shallow, island-studded body of water, 80 mi. wide, separating the southwestern part of the Australian Territory of Papua in New Guinea from Cape York Peninsula in northeastern Australia at 10° S. lat., and 142° 30′ E. long., and connecting the Coral and Arafura seas. The strait is named after the Spanish navigator Torres, second-in-command on De Quiros' voyage of discovery, who sailed through the strait in 1606. Thursday Island is the center of activity for a fleet of small vessels plying the waters of the strait in search of pearls and pearl shell. R. G. B.

**TORRES Y VILLARROEL, DIEGO DE** [to′rres i vilyɑrroɛ′l] (1693-1770), Spanish author, was born in Salamanca. He studied the humanities there for a short period but at the age of twenty ran away to Portugal in a successful search for an adventurous life. On his return to Spain, Villarroel lived in poverty in Madrid for a time, but he presently returned to his studies, and after completing courses in medicine and mathematics, was appointed professor of mathematics at the University of Salamanca in 1726. He was ordained a priest in 1745 and died in 1770.

Villarroel's works are a complete expression of his unconventional life. He consciously lived, as he admitted, like a "character from a picaresque novel," and this curious self-realization was expressed in his outstanding work, the autobiographical *Vida, ascendencia, nacimiento, crianza y aventuras del doctor don Diego de Villarroel* (first part, 1745; second part, 1752; third part, 1758) ("The Life, Ancestry, Birth, Education, and Adventures of Doctor Diego de Villarroel"). This is the last great picaresque novel in Spanish literature, differing from all others in that it tells the history of a life deliberately picaresque, of a man who wanted to live as had Guzmán de Alfarache and Lazarillo de Tormes. Even Villarroel's style reflects this joining of literature to life; it is uneven, unpolished, and disorderly, but it contains an amazing vitality.

Villarroel also wrote satirical poetry in the manner of Quevedo, but these poems were mostly written for particular occasions and have consequently lost much of their original interest. The *pronósticos* ("Predictions"), poems published annually in which he foretold the future, gave him enormous popularity. He appeared to have a certain intuition of what was to come and was seemingly able to predict such historical events as the French Revolution. Many people believed that Villarroel possessed supernatural powers, yet he himself consistently attacked the many superstitions prevailing at the time with almost the same intensity and open belligerence as his contemporary, Feijoo. He is undoubtedly one of the most extraordinary figures of the Spanish eighteenth century. Although he lacked the serenity of the Spanish rationalists, who were under French influence, he was far more characteristically Spanish in his devotion to a mixture of science and folklore, anarchism and method. J. A. L. M.

**TORREYA** [tɒ′riə], a small genus of evergreen trees of the yew family, also called *Tumion*. The California nutmeg, *T. californica,* can be grown satisfactorily in the southern and central United States; but in more northern regions it may become deciduous. The glossy, needlelike leaves, dark green above, have two whitish bands on the under side. The drupelike fruits, which ripen the second season, are green, streaked with purple. The whorled branches give the 70 ft. tree a pyramidal effect. *T. taxifolia,* the stinking cedar, is found in only a limited area in northwestern Florida and adjacent Georgia, and is somewhat smaller, growing to about 40 ft. C. H. Wo.

**TORREY PINE.** *See* SOLEDAD PINE.

**TORRICELLI, EVANGELISTA** [to′rritshɛ′lli] (1608-1647), Italian physicist and mathematician, was born Oct. 15, 1608, in Faenza. In 1627 he went to Rome and studied mathematics under Benedetto Castelli. After reading avidly the works of Galileo on motion, he composed a treatise on the same subject entitled *Trattato del moto.* He then became Galileo's pupil and secretary and later succeeded him as professor of mathematics and philosophy in Florence.

In 1643, Torricelli expanded on the findings of Galileo and proved that air has weight and that a suction pump cannot raise water more than about thirty-three feet. Aided by Vincenzo Viviani (1622-1703), Torricelli discovered that when a tube closed at one end having a length greater than thirty inches is filled with and inverted in a dish of mercury, the mercury in the tube reaches a height of approximately thirty inches above the mercury level in the dish, leaving a vacuum in the upper end of the tube. From this Torricelli

inferred that the pressure of the atmosphere on any area is equal to the pressure that a column of mercury thirty inches high would have on the same area. This was, in effect, the first barometer, and many barometers at present are identical with Torricelli's tube. Aside from his invention of the barometer, Torricelli is well known for a theorem in fluid mechanics. This states that if a hole is opened in the side of an open vessel filled with a liquid, the velocity of the resulting liquid jet, neglecting exit losses, is the same as if the liquid had fallen freely through a distance equivalent to the height of the surface of the liquid above the hole. He died in Florence Oct. 25, 1647. I. B.

**TORRINGTON,** a city in northwestern Connecticut, in Litchfield Co., on the Naugatuck River, about 19 mi. north of Waterbury. Torrington was settled in 1737 and incorporated as a township in 1740. A woolen mill was built by the Wolcott family in 1813 and the village became known as Wolcottville until 1887, when Torrington was incorporated as a borough. In 1923 it was chartered as a city. Brass kettles were made here in Colonial times and the city is still a noted brass manufacturing center. In August 1955 Torrington suffered severe flood damage and many of its industries, including bearings, hardware, electrical appliances, woolen goods, and its brass works were seriously affected. It is on a branch of the New York, New Haven, and Hartford Railroad. Pop. 1950, 27,820.

**TORTOISE** [tɔ′rtəs], properly, any member of the family Testudinidae, characterized by unwebbed feet having stubby digits, hind feet which are often elephantlike, and a plated snout; often, a terrestrial species of another family, as the box tortoise, a land-living pond turtle, Emydidae; occasionally, an aquatic form, as the hawksbill "tortoise." The world over, true tortoises are, and have been for millions of years, remarkably alike in that they have a high-domed form, but they vary greatly in size and pattern, carapaces ranging from uniform black to geometric patterns of bright colors. The hinge-back tortoises of Africa, *Kinixys,* protects its indrawn head and limbs by closing the carapace. The pancake tortoise, *Malacochersus tornieri,* of East Africa, which lays a single egg, has its shell reduced to a bony framework; it can squeeze into a rock crevice, inflate the body, and defy extraction. *See also* Box Tortoise; Giant Tortoise. M. G. N.

**TORTOSA** [tɔrto′sɑ], a city, the seat of a bishop, in the province of Tarragona (Catalonia), northeastern Spain. It is strategically situated on the left bank of the Ebro River, 20 mi. from its mouth, and enjoys an essentially Mediterranean climate. Known to the Romans as Colonia Julia Augusta Dertosa, it was taken in 718 by the Arabs who held it almost continually until the twelfth century. Tortosa was named the object of a crusade by Pope Eugenius III in 1148, and Ramón Berenguer IV, Count of Barcelona, took it with the aid of Italian forces. The French captured it in 1708 and again in 1811, holding it until 1814. The older quarter of Tortosa, crowded between the river and the nearby hills, has narrow, winding streets and ancient, stone houses. The Cathedral was built (1158-1178) on the site of a mosque of the time of Abd-er-Rahman III (891-961). It was given Gothic form in the fourteenth century and Baroque features were added later.

The city's products include paper, ceramic articles, leather, glass, and soap, as well as marble and alabaster from near-by quarries. It also acts as trading center for the abundant crops of rice, fruit, olives, and vegetables grown in the surrounding fertile *campiña* region. Tortosa is on the Valencia-Barcelona railroad. Pop. 1940, 38,269. R. G. W.

**TORTUGA** [tɔrtu′gɑ], the name of two islands located in the West Indies. The more northerly, also known as La Tortue, lies just north of Port de Paix, Haiti, and belongs to that country. This island, which is about 23 mi. long from east to west and about 4 to 5 mi. across, is of limestone structure, rising through several terraces to about 1,100 ft. elevation. The semiarid soil supports only a transient population. The island is best remembered as a buccaneers' hideout and stronghold during the seventeenth century and as a penal colony subsequently.

The second Tortuga, a Venezuelan possession, lies 50 mi. north of Barcelona on the Venezuelan coast and the same distance west of Margarita Island. It is of irregular shape, about 15 mi. long from east to west and with a maximum width of about 7 mi., and is inhabited by a few pearl fishers. J. E. F.

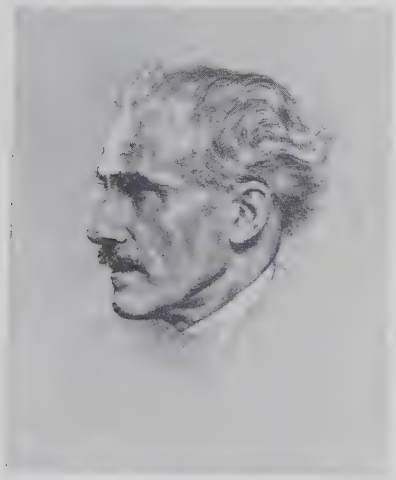
**TORY PARTY,** a political organization in England which originated in the reign of Charles II (1660-1685) when Thomas Osborne, 1st Earl of Danby, built up a royalist bloc in Parliament on the old Cavalier principles of a wide royal prerogative, the supremacy of the Anglican Church, and, in the economic sphere, an attachment to the landed interest. "Tory" was a nickname that had earlier been applied to Irish outlaws. The natural alliance of the Tories and the monarchy was broken by the Revolution of 1688, and the Hanoverian accession in 1714 kept them out of office for nearly half a century. They remained politically active, however, and in the duel for empire with France (1690-1763) they were isolationists and endeavored to keep England free from entanglement in Continental affairs. After George III succeeded in breaking the Whig dominance early in his reign, coalitions of factions rather than of parties governed the country until William Pitt the younger became prime minister in 1784, opening a period of Tory ascendancy. English reaction against the French Revolution and the war with France kept the Tories in office, save for one brief interval, until about 1830, when the Tory Party gave way to its successor, the Conservative Party. Despite a general reactionary temper the Tories were responsible for notable reforms under the guidance of George Canning (1822-1827). *See also* Conservative Party. A. H. Sw.

**TOSCA, LA** [lɑ to′skɑ], an opera in three acts by Giacomo Puccini with a libretto by Luigi Illica and Giuseppe Giacosa derived from the play of the same name by Victorien Sardou. The opera was first performed on Jan. 14, 1900, in Rome. Puccini here borrowed from both Verdi and Wagner. On the one hand, he used the Wagnerian leitmotiv and was not averse to new harmonic and instrumental devices when they could be used for dramatic effect; on the other, he modeled his soaring and expressive melodies on the typical Italian form developed by Verdi, though he maintained their tension in a way that Verdi, the great master of dramatic contrast, would never have done.

The story of *Tosca* is set in Rome about 1800, during the struggle between the monarchists and Bonapartists. Young Angelotti (bass), an escaped political prisoner, has been hiding in a Roman church with the assistance of his friend the painter Cavaradossi (tenor), who is the lover of the opera singer La Tosca (soprano). The villainous Scarpia (baritone), chief of police, arrests Cavaradossi for concealing Angelotti and proposes to execute him for this offense, but Tosca bribes Scarpia to order a mock execution by the prom-

ise of her favors. Neither Tosca nor Scarpia intend to keep faith, however; Tosca stabs Scarpia as soon as she is alone with him after he has ordered the executioners to use blank cartridges, and the officer in charge of the execution understands that despite his orders Scarpia intends the mock execution to be a real one. When Tosca realizes that her lover is dead and the murder of Scarpia discovered, she commits suicide by throwing herself over the wall of the prison castle Sant' Angelo into the Tiber. S. C.

**TOSCANINI, ARTURO** [to'skɑni'ni] (1867- ), Italian operatic and orchestral conductor, was born in Parma, Mar. 25, 1867. He began his career as a cellist, but dur-



ARTURO TOSCANINI

FROM A DRAWING BY LOUIS LUPAS

ing the 1886 Rio de Janeiro opera season Toscanini was catapulted into the conductor's role when the local director was hissed from the podium. In the years following this spectacular debut, Toscanini conducted principally at the Metropolitan Opera House (1908-1915) and at La Scala in Milan (1921-1929). His tenure as conductor of the Philharmonic Symphony Society of New York (1928-1936) raised that organization to new heights. In 1937 he became director of the newly formed National Broadcasting Company Symphony Orchestra, a position he held until his retirement in 1954. His enormous fame rests primarily on his interpretation of Italian and Wagnerian music. E. L. F.

**TOTALITARIANISM.** *See* Political Science and Philosophy (*Political Philosophy*).

**TOTEMISM.** *See* Primitive Religion (*Forms and Concepts*).

**TOTEM POLE,** a large girdled tree trunk decorated with painted carvings and erected by a family head or clan chief in front of his house as a memorial to his deceased predecessor. The design, being in the nature of a family or clan crest, usually contains a representation of the owner's guardian totemic animal and for this reason the memorial eventually was given the name of totem pole. These striking art objects have been found along the North Pacific coast from below the Canadian border to Alaska. There is reason to believe that they originated at or near the estuary of the Nass in British Columbia just south of the Alaskan border. Only on the Nass and the adjacent Skeena did the art penetrate far into the interior.

Until recently it was generally believed that this indigenous Indian art was of great antiquity. This view is now discredited. The first erection of totem poles now appears to date from the early nineteenth century. Late eighteenth-century explorers make no mention of these conspicuous objects although they do describe the Indian practice of painting and carving house fronts, exterior house posts, and interior beams. The origin of this art, therefore, lies well within the period of European contacts. The first contacts brought not only new tools but also strange ideas to stir the imagination of the Indian. The art forms, however, remained indigenous. Toward the end of the nineteenth century the art of making totem poles had begun to decline. It is now practically extinct. Two influences helped to hasten the decay of this once great art: Canadian and American contacts with the Indians eventually broke down tribal morale, and the Indian desire for prestige led to the substitution of impressiveness and size for the former creative artistry. W. M. W.

**TO THE LIGHTHOUSE** (1927), a novel by Virginia Woolf. It deals with the problem of attaining an organic relationship between human beings who are kept apart by their egocentricity. During the first part, "The Windows," Mrs. Ramsay, the central character, seeks through her charm and understanding to integrate her family and guests, including the penniless student Charles Tansley and the poet Mr. Carmichael, who are visiting at the Ramsay summer home in the Hebrides. The theme is continued through the efforts of Lily Briscoe to achieve form in her painting, which she does just as Mr. Ramsay and his son James reach the lighthouse, a symbol of unifying force. L. F. D.

**TOTOWA** [to'towə], a borough in Passaic Co., in northeastern New Jersey, situated southwest of the city of Paterson of which it is a residential suburb. A considerable part of the population is employed in the silk and dye mills of Paterson. During the Revolutionary War George Washington and his troops had a camp in Totowa and used a vacant field as drill-grounds. Totowa was settled by the Dutch. It is governed by a mayor and council. Pop. 1950, 6,045.

**TOUCAN** [tukɑ'n; tu'kan], any one of a number of species of medium-sized to large birds united in the family Ramphastidae. Although very different in appearance, they are allied to the woodpeckers, jacamars, and puffbirds. Tou-

TOUCAN

YLLA

cans are found in the tropical regions of the New World from Mexico to Argentina. Their most remarkable characteristic is an enormous, serrated bill, somewhat like the claw of a lobster, and usually found in a variety of gaudy colors.

Despite its solid appearance, the bill is hollow and quite light. Their plumage may be largely green or almost indescribable combinations of the brightest hues. Toucans inhabit the taller trees of dense forests, often traveling in bands, and feed mainly upon fruits, although they do not refuse large insects and their larvae, amphibians, lizards, or even small birds. They lay their white eggs in holes in trees. H. G. De.

**TOUCHSTONE,** the fool, or clown, in Shakespeare's comedy *As You Like It.* He accompanies Rosalind and Celia into exile in the Forest of Arden, where he woos and wins the country wench Audrey, "an ill-favour'd thing, sir, but mine own." Touchstone is a notable example of the Shakespearean fool, whose apparent witlessness is merely the cloak that disguises a paradoxical wit. R. V. L.

**TOUGALOO COLLEGE** [tugəlu′], an accredited, coeducational institution of arts and sciences for Negroes, affiliated with the Congregational and Christian Churches of America. The campus covers about 500 acres in Tougaloo, Miss. First instruction was given in 1869. The first four-year college course was offered in 1897. Only the A.B. degree is offered in liberal arts. Students from outside the city must live in the college residence halls or in approved homes. The majority of the scholarship awards are restricted to Mississippi residents. Opportunities for self-help exist. *For statistics see* COLLEGES AND UNIVERSITIES. J. R. To.

**TOULON** [tu′lɔ̃′], a leading naval arsenal of France, situated in the department of Var on the Mediterranean coast, 410 mi. southeast of Paris and 30 mi. southeast of Marseille. It lies at the head of a deep bay, sheltered by a breakwater, beyond which is a vast roadstead protected by the peninsulas of Cap Cépet and Cap de Giens.

Said first to have been settled by the Phoenicians, the site was known to the Greeks as Telenion and to the Romans, who made it a naval station, as Telo Martius. Bequeathed by the last descendant of the Viscounts of Marseille to Charles of Anjou, Count of Provence, it passed in 1481, with the rest of Provence, to the King of France. Although it was fortified during the reign of Louis XII (1498-1515), it became an important stronghold only during the reign of Henry IV (1589-1610). During the War of the Spanish Succession, it resisted in 1707 a combined attack by Austrian and Sardinian land forces and English and Dutch fleets. The Royalists of the city handed it over to the British during the French Revolution; but after a three-month siege, during which Napoleon Bonaparte first distinguished himself, the Republican Army recaptured it in December 1793. During World War II, the French on Nov. 27, 1942, scuttled their fleet, at anchor there, to prevent its falling into German hands. Toulon was much damaged in the course of the war before its liberation on Aug. 28, 1944.

Toulon derives its support from naval activities, fishing, the tourist trade, and marketing of farm produce. The local manufactures include chemicals, soap, pottery, carpets, and briar pipes. Pop. 1954, 141,117. W. McE.

**TOULOUSE** [tu′lu′z], capital of the department of Haute-Garonne in southwestern France, near the foothills of the Pyrenees on a bend of the Garonne River, 360 mi. south of Paris and 130 mi. southeast of Bordeaux. Known originally as Tolosa, Toulouse, now a university and trade center often called the "rose-red city" because of its many brick buildings, was a stronghold of the Gauls. When the Merovingian ruler Dagobert created the kingdom of South Aquitaine in 628 for his brother Charibert, Toulouse became its seat. After the establishment of their independent countship in the ninth century, the power of the Counts of Toulouse grew until by the beginning of the twelfth century they controlled the greater part of southern France. The support lent by Count Raymond VI to the Albigensian rebellion against the Church of Rome led to a siege of the city in 1211 by the forces of Simon IV de Montfort l'Amaury. He occupied the town in 1215, but lost his life in another siege in 1218. In 1271 Toulouse passed to the crown of France. As capital of the royal province of Languedoc, it became the seat of the parlement of Toulouse, founded in 1302, which acquired a reputation for its stern measures against religious heretics. Toulouse was invaded by the British after the Duke of Wellington defeated Marshal Soult in battle on Apr. 10, 1814, on the heights to the northwest. The marketing center of an important agricultural region, Toulouse has food and beverage processing plants, flour mills, distilleries, bakeries, chemical works, soap plants, hat factories, and foundries. Pop. 1954, 268,863. W. McE.

**TOULOUSE, UNIVERSITY OF,** at Toulouse, France, the third oldest French university, founded in 1229. In the Treaty of Paris, Blanche of Castile, regent for Louis IX, on Apr. 12, 1229, compelled Raymond VII, Count of Toulouse, to establish a university as a means of extending orthodox thought and combating the Albigensian heresy. To do this, the count took over the Collège de St. Raymond, founded at the end of the eleventh century and now maintained as a museum. The university was first granted full privileges as a *studium generale* with fourteen chairs in 1233 by a Papal Bull of Gregory IX. By 1500 the university had ten colleges, all the ecclesiastical type. In 1751 the University of Cahors, founded in 1332, was merged with Toulouse. During the French Revolution at the end of the century the university was closed; reopened in 1805, it was reorganized in 1896. The university includes faculties of law, science, letters, medicine, and pharmacy. In 1948 the enrollment totaled 7,190, and the staff numbered 109. The library contained 1,290,376 volumes. A. L. H.-Q.

**TOULOUSE-LAUTREC, HENRI DE** [tu′lu′z lo′-trɛ′k] (1864-1901), French painter and lithographer, was born of ancient noble lineage at Albi, Nov. 24, 1864. He was a delicate child and became dwarfed when his legs, which were broken several times, healed improperly. His father, an ardent sportsman, disdained an artist's career for his son, but permitted the precocious boy to study with his friend, the sporting painter René Princeteau. In 1882 Lautrec went to Paris to study under the academic artists Léon Bonnat and Fernand Cormon, but after a year he tired of their instruction and established his own studio. In his desire to interpret modern life he turned to the Impressionists, particularly to the work of Hilaire Degas. He adopted the older artist's point of view, but quickly developed his own angular and nervous variations of Degas' linear pattern. Among other things which influenced his painting were Japanese prints, from which he derived his characteristic oblique design and simplified perspective.

By birthright Lautrec might have moved in the highest Parisian society but, possibly because of his affliction, he preferred the company of artists, theatrical people, and cabaret entertainers. His subjects, which he interpreted with remarkable psychological insight, were almost exclusively drawn from the night life of Paris, centered in the restaurants and dance halls of Montmartre. In addition to his painting,

executed in a variety of media frequently experimental, Lautrec was a prolific lithographer, producing not only independent prints but numerous book illustrations and commercial posters. These were among the first to be designed by an artist of his rank and exercised considerable influence on similar work in England and the United States. Lautrec's frail body could not long support a life of intense artistic effort combined with unmitigated physical indulgence. In 1899 he retired to a sanatorium. Although false rumors circulated that he was insane, during his confinement he produced from memory an astonishing series of circus drawings. A few months after his release he died at the family château of Malromé, Sept. 9, 1901. G. H. H.

**TOURACO** [tu′ra′ko′], any one of a number of species of medium- to large-sized nonsinging birds united in the family Musophagidae and allied to the cuckoos. They inhabit most parts of tropical Africa south of the Sahara Desert. Touracos are characterized by a heavy, sharp-edged bill, a bushy, erectile crest, an unusually long tail, and feathers of silky texture. The red wing feathers of certain forms yield a reddish-violet pigment, turacin, that contains copper. Their plumage may combine soft browns and grays or may show brilliant greens, blues, and reds, set off by black and white. These birds, sometimes known as plantain eaters, live in wooded country and feed chiefly on fruits. Their voices are extraordinarily loud and harsh. H. G. De.

**TOURAINE** [turɛ′n], former French province in west central France, bounded by the provinces of Anjou on the west, Maine on the north, Orléanais on the northeast, Berry on the east and southeast, and Poitou on the southwest. Its capital was Tours. The Turones, a Gallic people, submitted to Caesar during his first campaign in Gaul, but in 52 B.C. joined in the revolt under Vercingetorix. During the barbarian invasions the region was conquered by the Visigoths in 475 and by the Franks between 494 and 507. Under Frankish rule, and under Charlemagne, it was a countship. In 1044 it came under the rule of Anjou and passed with that province to the ruling house of England. In 1203 Philip Augustus of France confiscated the English holdings. In 1356 John the Good made Touraine a duchy for his son Philip, who later became Duke of Burgundy. It continued an appanage of the sons of the royal family until, on the death of the Duke d'Alençon, it was united to the crown in 1584 by his brother. Four important residences of the French kings were in Touraine: Loches, Plessis-les-Tours, Blois, and Chinon, where Joan of Arc asked Charles VII to form an army for her. The old place-names of Touraine are among the best known in France as a result of the writings of Gregory of Tours (c.538-593). In 1790 the province was divided among the present administrative departments of Indre-et-Loire, Loir-et-Cher, Indre, and Vienne. F. C. H.

**TOURCOING** [tu′rkwæ̃′], manufacturing city of northern France, in the department of Nord, within 1 mi. of the Belgian frontier, and 8 mi. northeast of Lille. It is closely united with the neighboring city of Roubaix to the south. Tourcoing is one of the most important textile centers of France. Its chief industries are wool-processing, and the manufacture of woolen, cotton, and silk goods. It is especially noted for its carpets. The sugar industry is also important, and other industries include brewing, tanning, dyeing, and the manufacture of soap, textile machinery, and hardware. Historically, Tourcoing is notable as the scene of the defeat of the Austrians and the English by the Republican army, under Moreau and Souham, in 1794. During World War I, the city lay in the path of the great battles of 1917 and 1918 and was severely damaged. The only building of note is the Gothic church of St. Christophe, rebuilt in 1862 in fifteenth-century style. Pop. 1954, 83,416. C. W. D.

**TOURMALINE** [tu′rməlɪn; tu′rməlin], a complex silicate of boron and aluminum. Ca, Mg, Mn, Fe, Li, and Cr may be part of the formula in some varieties. Tourmaline has a hardness of 7-7.5 and a density of 2.98-3.20. Indices of refraction vary from 1.619-1.643. Tourmaline is strongly dichroic, a conspicuous feature of the mineral. Tourmaline crystallizes in the hexagonal system. Tourmaline is also noted for producing piezo-electric and the pyro-electric effects. The fine, clear-colored species are much in demand as gemstones. Tourmaline occurs in a wide range of colors which have given rise to many varietal names. Rubellite, indicolite, achroite, dravite and schorl have been applied to the red, blue, colorless, brown, and black varieties respectively. Still other colors are green, yellow, and pink. Tourmaline may exhibit several colors in the same crystals. The line of demarcation between the colors is often very sharp. Colored varieties from Brazil are known in the trade as "Brazilian emerald," "ruby," and "sapphire." The mineral is found in granite and pegmatite rocks as well as in formations which owe their origin to metamorphism—the schists, gneisses, and crystalline limestones. Fine specimens of tourmaline, of large size, are found in many parts of the world. The Ural Mountains of Russia, the Minas Gerais province of Brazil, Ceylon, and Madagascar are sources of tourmaline. Many gem crystals have been obtained from Paris, Maine; Haddam, Connecticut; and Pala, California. The province of Ontario, Canada, has numerous deposits of the mineral. Tourmaline does not fluoresce when subjected to either ultraviolet or X-ray radiation. A. E. A.

**TOURNACHON, FÉLIX** [tu′rna′shɔ̃′] (1820-1910), better known by his pseudonym, "Nadar," French aeronaut, journalist, and photographer, was born in Paris, Apr. 5, 1820. Professionally a journalist, caricaturist, and photographer, he became interested in aeronautics about 1860. He collaborated in the design of a steam-driven helicopter displayed at the London Aeronautical Exhibit in 1868. His great balloon *Le Géant,* first flown in 1863, was 196 ft. high and 100 ft. in diameter, could lift well over four tons, and was the largest balloon built up to that time. Nadar was one of the earliest experimenters with aerial photography, but his efforts were unsuccessful, and credit for the first satisfactory aerial photographs went to William Black for his views over Boston in 1860 from the balloon of Samuel Archer King. Nadar's organization of the Balloon Post during the Siege of Paris in the Franco-Prussian War in 1870 and 1871 was his greatest achievement. Between September 1870 and January 1871 sixty-five balloons were built and flown to points outside Paris successfully, carrying 164 persons, 381 carrier pigeons, and over 20,000 lb. of mail. One of Nadar's exploits in 1870 was his victory over a Prussian observer in an aerial pistol duel from balloons over Paris. He died in Paris, Mar. 21, 1910. M. H. Sm.

**TOURNAI** (*Fl.* Doornik) [tu′rne′, do′rnɪk], a small city in the province of Hainaut, in southwestern Belgium, on the Schelde River, 45 mi. southwest of Brussels, near the French border. An ancient community, Tournai was occupied in Julius Caesar's time and called Civitas Nerviorum

or Castrum. In the fifth century it was the seat of the Merovingian kings. Throughout its history until Belgium became an independent nation in the 1830's, Tournai was a strategic objective of all invading armies. In World War I the city once again was subjected to enemy attack. In August 1914 the Germans captured Tournai, remaining in control until Nov. 8, 1918, when the British entered the city. The city did suffer some damage in World War I, but it was negligible compared to that resulting from bombing raids and occupation during World War II. Most of the damage to important buildings was the result of German incendiary bombing in 1940. The famous cathedral of Notre Dame was damaged, and the chapel adjoining the cathedral was completely gutted by fire. The destruction was particularly disastrous to the old section of Tournai, but many buildings and notable examples of Medieval architecture have been restored. The Museum of Fine Arts and the Church of St. Jean Baptiste escaped unscathed. The notable industries of the city include the manufacture of carpets, embroideries, and porcelain. Pop. 1952, 32,528. S. D. M.

**TOURNAMENT.** *See* Jousts and Tournaments.

**TOURNEUR, CYRIL** [tɜ′rnər] (c. 1580-1626), English author, was born about 1580. The earliest known fact of his life is that in 1600 he published *The Transformed Metamorphosis,* a satirical allegorical poem. He became secretary to Sir Francis Vere, English general in the Netherlands, of whom he wrote *A Funeral Poem* (1609). His play *The Atheist's Tragedy* was published in 1611, and *The Nobleman,* now lost, was acted in 1612. Tourneur wrote a *Character* of Robert Cecil, Earl of Salisbury, and *A Grief on the Death of Prince Henry.* After carrying government despatches to Brussels in 1613, he held military office under Sir Edward Cecil and the States of Holland. The Privy Council imprisoned him briefly in 1617, but in 1625 appointed him secretary to the council of war on Cecil's expedition against Cádiz. Tourneur became ill during the voyage and died at Kinsdale, Ireland, on Feb. 28, 1626.

*The Revenger's Tragedy,* a masterpiece of Jacobean drama, has been commonly attributed to Tourneur, but without adequate evidence. Published anonymously in 1607, it was assigned to Tourneur by later booksellers, but scholars are not agreed whether Tourneur or Thomas Middleton was its author. Tourneur's one certain extant play, *The Atheist's Tragedy,* expresses a Christian stoicism very different from the imaginative passion of *The Revenger's Tragedy.*

M. E.

**TOURNIQUET.** *See* First Aid.

**TOURS** [tu′r], a city in west central France, on the Loire River, about 130 mi. southwest of Paris. It is the chief city of the department of Indre-et-Loire. Before the Roman conquest of Gaul, Tours was an important village of a Gallic tribe called Turones. The Romans moved the settlement from the north bank of the Loire to its present site south of the river and named it Caesarodunum. Later known as Urbs Turonum, or Turoni, the community was made the capital of a Roman province in Gaul A.D. 374. It was overrun by the Visigoths in 473 and captured by the Franks in 507. In 732 the Frankish ruler, Charles Martel, defeated an invading Arab army near Tours in the decisive battle that effectively destroyed the Moslem threat to France. Tours subsequently became the capital of the counts of Touraine. It passed under the English crown when Eleanor of Acquitaine married Henry II of England but was returned to French dominion after Eleanor's death in 1204. Tours grew rapidly and became extremely prosperous. It was a favorite residence of French kings, and the Estates General met frequently in the city. Tours developed into an important silk-weaving center, but when the revocation of the Edict of Nantes in 1598 forced 40,000 Protestant workers to flee the city, Tours declined in importance and has never regained its former prestige. The city was the provisional capital of France for three months in 1870 during the Franco-Prussian war and was occupied by the Prussians in January 1871. In 1940, during World War II, the French government sought refuge in Tours before going on to Bordeaux. The city was bombed and its old quarter along the Loire was severely damaged.

BURTON HOLMES FROM EWING GALLOWAY

*View of Tours, France*

Tours now extends from the Loire south to the Cher River. It is divided into four sections by two broad boulevards that intersect at right angles. At their intersection are the Hotel de Ville and the Palais de Justice, while in the northeast section of the city is the Cathedral of St. Gatien. The cathedral, begun in the twelfth and finished in the sixteenth century, is noted for its magnificent stained-glass windows and its fifteenth-century cloisters. In the same section of the city stand two towers, all that remains of the ancient basilica of St. Martin, which was praised in the sixth century by Gregory of Tours, rebuilt in the twelfth and thirteenth centuries, and almost completely destroyed during the French Revolution. Near by is the tomb of St. Martin. In the old northwest section are such relics of the fifteenth and sixteenth centuries as the Hotel Gouin, the House of Tristan l'Hermite, and the Fontaine de Beaune. Tours is the center of the historic chateaux district of the Loire Valley. Honoré de Balzac and the painters Clouet and Fouquet were born in Tours, and the philosopher Descartes was born in the vicinity. Aside from its historical importance, the city is also an educational center. The Institute of French Studies, a division of the University of Poitiers, created to serve foreign students, is located in the city along with schools of medicine and pharmacy, fine arts, and music. There is a museum of art in the former archiepiscopal palace and a library with a rich collection of manuscripts.

Tours is the principal market center for the rich farms of the surrounding area and is noted for the production of potted pork, dried prunes, wines, and brandies. Its industries manufacture silks and laces, carpets, metal products, hemp, paper, sealing wax, stained-glass windows, and books. Pop. 1954, 83,618.

**TOURS, BATTLE OF,** sometimes called the Battle of Poitiers, considered one of the decisive battles of the world, because it turned back the tide of Moslem invasion in western Europe, was fought in October, A.D. 732. In A.D. 711 the Moslems had crossed into Spain from northern Africa and rapidly overrun the Visigothic kingdom. Advancing into southern Gaul, they defeated Eudo of Aquitaine at Bordeaux, took Poitiers, and pressed on toward Tours. Not far from Poitiers they were met by the Franks under Charles Martel, augmented by the remains of Eudo's forces. After a week's delay the battle was joined, and at the end of a day's furious fighting the Moslems withdrew from the field, having suffered great losses, including the death of their leader, Abd-er-Rahman. Charles obtained the acclaim of the western world as the champion of Christendom, and the Moslem hold on France was reduced to a small territory in the south. F. C. H.

**TOUSSAINT L'OUVERTURE, PIERRE DOMINIQUE** [tu'sæ' lu'vɛ'rtü'r] (1743-1803), Haitian general and liberator, was born near Cap François in 1743. A Negro slave, he joined the forces of the insurgent Haitian blacks in 1791 and advanced rapidly in the native army. When the French government proclaimed the freedom of the slaves, Toussaint sided with the French military effort to oppose British interests on the island. In 1797 the French named him commander-in-chief of the troops in Santo Domingo. Expelling the English and Spaniards, he soon established his rule in Haiti, and under his able and just administration the country prospered. When Toussaint challenged the authority of France in 1801, Napoleon sent a strong force under General Charles Leclerc to subdue the self-styled "Bonaparte of Santo Domingo," who was captured and allowed to retire to an estate. Shortly thereafter he was detected conspiring against the French and was sent to France, where he died in prison near Besançon, Apr. 27, 1803. G. Q.

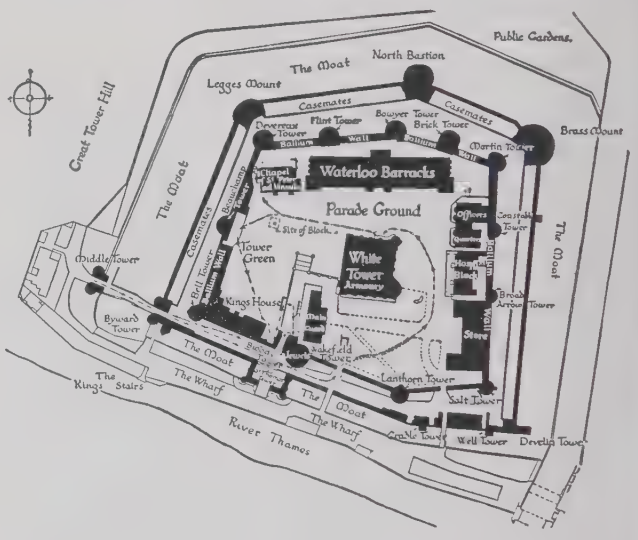
**TOWBOAT.** *See* VESSELS, INLAND WATERWAY.

**TOWER OF LONDON,** a fortress, garrison, and museum on the north bank of the Thames River in London, England. Including the surrounding gardens, the Tower covers eighteen acres, twelve of which are within the outer walls. It is surrounded by a wide, deep moat, now dry, which is used as a parade ground. Originally there were only two entrances: the Middle Tower and St. Thomas' Tower, the latter giving on to the river through the Traitor's Gate, which retains its original portcullis.

The oldest and central part of the fortress is the White Tower, built by William the Conqueror in 1078, which is a castle in itself. The name refers to the Caen stone used in its construction, and it was whitewashed in medieval times. It incorporates the Chapel of St. John, an exceptionally fine and intact example of Norman architecture. The tower is 90 ft. high and houses the armories, the record room, the Tudor room (with Henry VIII's armor), and a large collection of cannon and other armament. The White Tower was held in pledge by the citizens of London for the completion of the Magna Charta, and many illustrious prisoners were lodged in it over the centuries, including Elizabeth and Mary Tudor.

A large modern barracks stands near the site of the royal palace destroyed by Oliver Cromwell, and near the barracks is the small twelfth-century chapel of St. Peter ad Vincula, containing, among others, the graves of Anne Boleyn and Catherine Howard, wives of Henry VIII, who were beheaded on the scaffold a few yards from the chapel. The executions of less important prisoners were carried out on Tower Hill, outside the fortress, or at Tyburn. The Beauchamp Tower is on the inner wall, and dates from the twelfth century. Among famous persons imprisoned there were Lady Jane Grey and Sir Walter Raleigh. The King's House, where Anne Boleyn was lodged before her execution, is a private residence. There are a number of other buildings, including the Wakefield Tower, which houses the crown jewels. Here, in a double cage, are displayed the crowns, scepters, and other regalia, some of which are used on state occasions.

Associated with the Tower of London are the famous Yeomen of the Guard, or "Beefeaters" (from the French *buffetier*), pensioners whose duties are directly connected with ceremonial occasions. Their costume is of the original Tudor design. To complete the medieval atmosphere are ravens, which have inhabited the green for several hundred generations. The nightly "Ceremony of the Keys" is performed




COURTESY OF THE BRITISH INFORMATION SERVICES

*Plan of the historic Tower of London, showing the route taken by visitors*

shortly after dark. The Yeoman Warder, carrying the keys and a lantern, and with an armed escort, locks the ancient doors of the Byward Tower; the present arms is given, and the Tower is considered closed until dawn. This custom has remained unbroken for more than 600 years. B. Su.

**TOWHEE** [to'hi; tohwi'], any one of a number of species of American finches united in the genus *Pipilo.* They range from southern Canada to southern Mexico. The best known are the closely allied *P. erythrophthalmus* and *P. maculatus,* the former of the eastern United States, the latter restricted to the west coast region. These are both 8 in. long. Male towhees have the upper parts black, the flanks rufous, but the remaining under parts white, and white patches in the wings and tail; the females are similar but have the black replaced by brown. The most familiar species of the Pacific coast is the somewhat larger (9½ in.) brown towhee, *P. fuscus,* which is mainly dull gray-brown, but has the top of the head light rufous. Towhees spend much of their time on the ground in woods and thickets, where they scratch among the leaves for seeds and insects. The name towhee, as also chewink, is derived from the calls of certain species. H. G. De.

**TOWIE.** *See* Card Games.

**TOWN, ITHIEL** (1784-1844), American architect, was born at Thompson, Conn., Oct. 3, 1784. He studied architecture in Boston under Asher Benjamin. Most of Town's houses were built in the Greek Revival manner. His most famous church, the Center Congregational Church on the New Haven Green, was started in 1812. The old Connecticut Capitol, also on the Green and since demolished, was the first Greek Doric "temple" in New England. In 1826, Town started his New York architectural practice, first in partnership with Martin Thompson and then, from about 1829, with Alexander J. Davis. Town and Davis made a good working team, since Town had been a carpenter and Davis was a good draftsman. This prolific firm designed a number of state capitols, including the one still standing at Springfield, Ill. Town also became famous as the inventor of the Town truss, used on many wooden and iron bridges of the period. Town influenced the taste of the country profoundly through the use of the Greek Revival style. In this respect he rivaled Benjamin H. Latrobe, who introduced it in the United States. Town died in New Haven, Conn., on June 13, 1844. F. J. R.

**TOWN GOVERNMENT.** *See* Local Government in the United States.

**TOWNSEND PLAN,** a plan for old-age pensions proposed in 1934 by Francis Townsend of Long Beach, Calif. Designed not only to relieve the aged, but offered as a panacea for recovery from the depression, the plan called for: (1) a pension of $200 per month for every American citizen 60 years of age or older, on condition that such pension be spent in 30 days within the United States, and that its beneficiaries withdraw from all gainful occupation; (2) pensions to be financed by a 2 per cent tax on all business transactions.

Well publicized, the plan attracted thousands of adherents from all parts of the country. Bills embodying its features were introduced into the 74th Congress. The *Townsend National Weekly* was established, and national conventions, attended by thousands of supporters, met in Chicago and Cleveland in 1935 and 1936. At its peak, the movement claimed 2,500,000 members and 25,000,000 supporters. It was a political force to be reckoned with in many states. With the development of the national program for social security, after 1935, and the recovery of the nation from the depths of the depression, the popularity of the movement waned and in 1948 had lost most of its political significance. C. T. P.

**TOWNSHEND,** the name of a distinguished English family, the most prominent members of which were the following:

**Charles Townshend** (1674-1738). Charles Townshend, second Viscount Townshend, eldest son of Sir Horatio, first Viscount Townshend of Rainham, in Norfolk. He was educated at Eton and King's College, Cambridge, and succeeded to the peerage in 1687. Although brought up as a Tory, Townshend soon joined the Whigs and was one of the junto who upheld religious liberty against the Occasional Conformity bill. In 1709 he visited the Hague as ambassador to the States-General and negotiated the Barrier Treaty (1710), ratifying the Hanoverian succession, but in 1711 was recalled for having exceeded his instructions and was voted an enemy of his country. On the accession of George I in 1714, he was appointed secretary of state for the northern department, but in 1716, he was dismissed on a charge of having obstructed the French alliance and of scheming to place the prince of Wales on the throne. In 1721 he was restored to this office. Townshend was a valuable ally of Sir Robert Walpole but differences later arose between them, and in 1730 Townshend resigned from the government, retiring to his estate at Rainham, where he died, June 21, 1738.

**Charles Townshend** (1725-1767). Charles Townshend, grandson of the second Viscount Townshend, attended Leyden University and entered parliament as a member for Yarmouth in 1747. He became successively lord of the admiralty (1754), treasurer of the chamber (1756), and secretary of war (1761). In 1762 he resigned his office, but accepted the presidency of the board of trade. On the return of Pitt to power in 1766, Townshend became chancellor of the exchequer and the most powerful minister in the House of Commons. He opposed Chatham's India policy and was the author of those measures for obtaining revenue from the American colonies that more than any other grievance brought about the revolt of the colonies. It was Townshend who suspended the activities of the New York Assembly and obtained passage of the measure taxing glass, paper, and tea on importation into America. He died suddenly, Sept. 4, 1767.

**George Townshend** (1724-1807). George Townshend, fourth Viscount and first Marquis Townshend, was educated at St. John's College, Cambridge, and in 1745 joined the army under the Duke of Cumberland. He fought at Culloden (1746) and Laufeld (1747). He was the author of the Militia Bill of 1757 and aide-de-camp to George II. He was appointed brigadier-general under Wolfe, in the Quebec expedition, and on the latter's death at the battle of Abraham Heights took over the chief command in 1759 and received the capitulation of the city. In 1767 he was appointed lord-lieutenant of Ireland, and aroused violent hostility. He was recalled in 1772 and became master-general of the ordinance. He died at Rainham, Sept. 14, 1807. C. W. D.

**TOWNSHEND ACTS, THE.** *See* American Revolutionary Period.

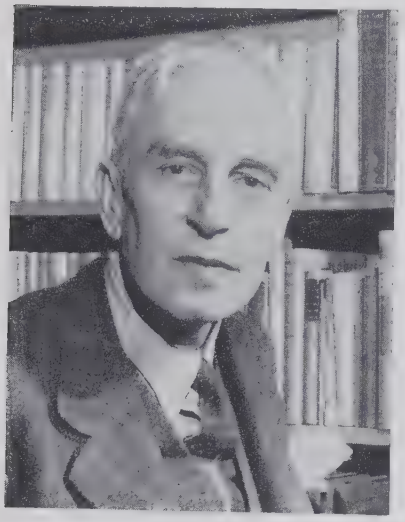
**TOWNSVILLE,** a city and the second largest port of Queensland, northeastern Australia, situated on Halifax Bay in Elphinstone Co. It is on the coast of the Coral Sea, and the Sea View Mountain Range is west of the city. Townsville has a tropical savanna type of climate, with high mean temperatures and between 50 and 70 in. of rain annually. Sugar is an important crop of the vicnity. Townsville was founded in 1864 by John Medwin Black, who named it after his partner, Captain Towns. It attained municipality status in 1866 and is the seat of the Anglican bishopric of North Queensland. The harbor is a regular port of call for both coastwise and overseas steamers, handling over 1,000,000 tons of freight a year. Townsville is also an important railway terminus. Pop. (off. est. 1947), 34,233. J. E. F.

**TOYAMA** [toyɑmɑ], the capital of Toyama Prefecture, on the western coast of Honshu Island, Japan. The city is situated just inland from Toyama Bay near the mouth of the Jintsu River in a noted rice-producing region. Like other cities of western Honshu, it has cold, wet winters, with a heavy snowfall. The summers are mild. Toyama's chief industries are cotton spinning and the manufacture of proprietary drugs, a business which began as early as 1680 and grew until thousands were employed in it. Leather goods,

wood pulp, and nitro-lime are also produced. Toyama University is in the city. Pop. 1950, 154,484.

**TOY DOG.** *See* Dog.
**TOYDON.** *See* Christmas Berry.

**TOYNBEE, ARNOLD JOSEPH** [tɔi'nbi] (1889- ), English historian, was born in London, Apr. 14, 1889, and educated at Winchester and at Balliol College, Oxford. From 1912 to 1915 he was a fellow and tutor of Balliol College, and in 1919 he was appointed professor of Byzantine and modern Greek language, literature, and history at London University. He resigned this post in 1924 to become director of studies in the Royal Institute of International Affairs; he is also research professor of international history in the University of London. Toynbee's outstanding work is his philosophical



ARNOLD JOSEPH TOYNBEE

INTERNATIONAL NEWS

*Study of History* (10 vol., 1934-1954). He has also written *Nationality and the War* (1915), *The New Europe* (1915), *The Western Question in Greece and Turkey* (1922), *Greek Historical Thought* (1924), *Greek Civilization and Character* (1924), *The World After the Peace Conference* (1925), and *Civilization on Trial* (1948), and he edited the *Survey of International Affairs* from 1920 to 1938. E. R. A.

**TRACERS, ISOTOPE.** *See* Isotope Tracers.
**TRACERY.** *See* Architectural Terms.
**TRACHEA.** *See* Respiratory System.

**TRACHINIAE** [trəkɪ'nɪi] (*The Women of Trachis*), a tragedy by Sophocles possibly written between 421 and 408 B.C. It tells the story of Deianira's fateful attempt to win back the love of her husband, the great hero Heracles, by sending him a robe which she had saturated with what she thought was a magic love potion but which was in reality a deadly poison given her under false pretenses by the vengeful centaur Nessus. The tragic outcome is her suicide and Heracles' agonized death. S. D. At.

**TRACHOMA.** *See* Eye (*Eye Diseases*).

**TRACHYTE** [tre'kait; træ'kait], a dense igneous rock that is considered to be the volcanic equivalent of syenite. It is composed chiefly of feldspar with lesser amounts of dark-colored minerals, such as hornblende, biotite, and, more rarely, pyroxene. Quartz is absent. The feldspar is mainly one of the potash types, with plagioclase and oligoclase less abundant. Phenocrysts, especially of feldspar, are so common that many trachytes are better described as trachyte porphyries. Carlsbad twinning may be recognizable in the large feldspar phenocrysts. Trachyte occurs in lava flows; the rock is often streaked due to consolidation while the lava was still in motion. Best known localities for trachyte are in Germany and Italy, but the rock is also found in the United States in the Black Hills of the Dakotas, in Colorado, in Missouri, and, in dikes, in the vicinity of Lake Champlain in New York. K. K. L.

**TRACK AND FIELD SPORTS,** a group of athletic contests involving the basic physical activities of walking, running, jumping, throwing, pushing, and pulling.

**Events.** The annual outdoor national championships of the Amateur Athletic Union, the track and field championships of the United States, include, in Olympic years, competition in the following events: 100-, 200-, 400-, 800-, 1,500-, 5,000-, and 10,000-meter runs; 110-, 200-, and 400-meter hurdles; 3,000-meter steeplechase; 3,000-meter walk; broad jump; high jump; pole vault; hop-step-and-jump; discus throw; javelin throw; 16-lb. shot put; 16-lb. hammer throw; and 56-lb. weight throw. (In non-Olympic years, British-measure equivalents are substituted for metric distances, as, for example, 1, 2, 3, and 6 miles for 1,500, 3,000, 5,000, and 10,000 meters.) Olympic track and field competition includes all of these events except the 200-meter hurdles, the 3,000-meter walk, and the 56-lb. weight throw, and adds the 10,000- and 50,000-meter walks, the marathon run (26 mi., 385 yd., or 42,000 meters), the 400- and 1,600-meter relays, and the decathlon.

Except for the A.A.U. outdoor championships in Olympic years, American track and field meets do not as a rule use the metric system. Outdoor high-school meets generally include most or all of the following events: 100-, 220-, 440-, and 880-yd. and 1-mi. runs; 120-, 180-, and 220-yd. hurdles; half-mile, mile, or medley relays; 12-lb. shot put; discus throw; javelin throw; high jump; broad jump; and pole vault. Outdoor meets at the collegiate or later level generally include all of these except the 180-yd. hurdles, the 12-lb. shot put, and, except in relay "carnivals," the half-mile and medley relays (although a medley relay is sometimes retained for college freshmen), and add the 16-lb. shot put and the 2-mi. run. The 16-lb. hammer throw and the 35- or 56-lb. weight throw are also included at times. A ¾-mi. event is run occasionally.

Indoor meets follow the same pattern, with certain exceptions. Sprint and hurdle events are held at shorter distances, usually 60 yd. Races at 600 and 1,000 yd. often replace or supplement the 440 and 880. Javelin, discus, and hammer throws are seldom held indoors.

Outdoor championships are also sponsored by the A.A.U. in road races at 10, 15, 20, 25, and 30 kilometers, in the marathon, in walking races, in relays, and in cross-country runs. Colleges and schools also sponsor cross-country runs.

**Tracks.** Except for road races and cross-country runs, most outdoor races take place on an oval track, made usually of a composition of finely crushed cinders and other materials. Most outdoor tracks in the United States measure 440 yd., 1 ft. in from the inner circumference. Indoor tracks are most often made of wood, are banked at the curves, and are much smaller than outdoor tracks, seldom measuring more than 220 yd., and frequently less.

**Scoring.** Meets are scored according to the number of teams or individuals competing; the larger the meet, the more places in each event count in the scoring. When three

places are counted, scoring is usually 5, 3, and 1, respectively, for the first three places. Four places are usually scored 5, 3, 2, and 1. Five places are usually scored 5, 4, 3, 2, and 1. In very large or very important meets, six places are sometimes counted; scoring may be 10, 8, 6, 4, 2, and 1, or 10, 5, 4, 3, 2, and 1. The team gaining most points in all events is the winner, although in England and elsewhere only first places count in team scores at times.

## SPRINTING AND RUNNING

The ancient Persians, Greeks, and Romans trained their soldiery in running as an important part of military preparation, and between wars, running became a sport. Like other sports, it declined during the Middle Ages, although still a part of military training. Running as a sport was revived during the nineteenth century, and interest in it was intensified with the revival of the Olympic Games in 1896.

Flat running events are usually classified either as sprints, middle distances, or long distances, although there is no universally accepted criterion and some events are classified differently at different times and occasions.

Sprints are short races, sometimes called dashes. The term usually applies to those races shorter than 440 yd. The runners start from a "crouch" start, with legs tense, from which they spring forward rapidly into full running motion. The sprints are run at full speed for their entire distance. Probably the greatest of all sprinters was the American, Jesse Owens, who won four gold medals at the 1936 Olympic Games.

Middle-distance events are those between the 440-yd. run and the 1-mi. run. The 440 and equivalent races are really extended sprints, with the runners going full speed from start to finish. In the 880 and mile, and comparative distances, the runners endeavor to pace themselves according to plan, running a little faster or slower at certain portions of the race to achieve maximum results for the race as a whole. Frequently, great runners are equally at home in two or more middle-distance events. Ted Meredith, Ben Eastman, John Woodruff, and Mal Whitfield could run brilliantly in both the 440 and 880. Mel Sheppard and Sidney Wooderson were great runners at both the mile and half mile. Bill Carr, on the other hand, specialized in the 440, and Roger Bannister, first to run a mile in less than four minutes, usually concentrated on the mile.

Long-distance races are all those events longer than the mile. Great runners at these longer races are often capable of exceptional performances at widely disparate distances. Emil Zatopek, the Czechoslovakian distance runner who won three events at the 1952 Olympics, was equally good at 3 mi. and 26 mi. Paavo Nurmi, the Finnish star of the 1920's, held world's records at distances from 1 mi. to 10 mi. Gunder Haegg, the Swedish runner whose great career reached its peak during World War II when the Olympic Games were not held, broke world records with seeming ease at distances from 1,500 to 5,000 meters.

*Relay Races.* Relay races are those in which four contestants, comprising a team, run separate, consecutive "legs." A small baton is carried from start to finish by the successive members of the team; if it is dropped it must be retrieved. The most popular American relay distances are 1 mi. (four equal legs of 440 yd.) and 2 mi. (four equal legs of 880 yd.). Other relay distances are a quarter mile, a half mile and 4 mi. Medley relays are those in which four legs of varying distances are run (example: 880 yd., 440 yd., 220 yd., 1 mi.). Track meets specializing in relay races, such as the Penn Relays and Drake Relays, are held annually.

INTERNATIONAL NEWS

*Competitors crossing the brook during the annual Eton steeplechase in Buckinghamshire, England*

## CROSS-COUNTRY AND STEEPLECHASE

The earliest cross-country race was the famous "Crick Run" at Rugby School in England, first held in 1837. This cross-country chase, with its hedges, streams, hills, and rough terrain, was in many ways the forerunner of the modern steeplechase, as well as of modern cross-country competition. Cross-country running on a national championship basis was begun in England in 1876. Cross-country races have been a part of every modern Olympic renewal, but only in the sense that the 26-mi. marathon is run over the roads and lanes of the countryside. True cross-country runs were held only in the 1912, 1920, and 1924 games.

A.A.U. rules governing cross-country running in the United States provide that the race can be started and finished on a regular track, but that the major part of the run should be over the countryside on a properly surveyed course, marked with flags (red to the left and white to the right) that can be seen at a distance of 125 yd. Cross-country runs are held regularly in the United States, usually during the autumn, and are sponsored by collegiate or scholastic conferences, or similar groups. Team championships are determined on a point basis; the first five runners to finish from each team are given points corresponding to the place in which they finish (first place, 1; second, 2; and so on), and the team with the lowest total score wins.

The steeplechase is an obstacle race. No official records are listed for steeplechase events, since no two steeplechase courses are exactly alike. The 3,000-meter steeplechase is the standard distance. Conducted on a 400-meter (equivalent to 440 yd.) track, the standard steeplechase includes five jumps to each lap, 80 meters apart. The jumps are wooden hurdles, about 3 ft. high and 12 ft. wide, and heavy enough not to be easily upset; some jumps include water pools.

## WALKING

Walking races, held at distances from 1 mi. to more than 30 mi., are those in which the contestants at no time lose contact with the ground. Losing contact is called running and is a violation for which the contestant can be disqualified. Developing speed within the restriction of ground contact has resulted in a peculiar gait in which the heel of the forward foot strikes the ground just before the toe of the rear foot leaves it. The legs at this point are perfectly straight. Walking has been called the "heel and toe" sport. A good walker can cover a mile in less than 7 min. Walking races were very popular in England during the nineteenth century, and retain their popularity in various parts of Europe. Most

*Taking the high hurdles in an intercollegiate event*

INTERNATIONAL NEWS PHOTOS

great walkers today are European. Once a common American pastime, walking races are relatively rare today in the United States; only the existence of the A.A.U. and Olympic walking championships keeps interest alive.

### HURDLING

Hurdling is a foot race, related to the steeplechase, in which the runner must leap over several low wooden barriers in the course of the race. Hurdling races are short: the longest is 400 meters (or 440 yd.). More common in the United States are the 120-yd. high and 220-yd. low hurdles. Indoor hurdle races are at shorter distances. Hurdle heights are: 110 meter (or 120 yd.), 3 ft., 6 in.; 200 meter (or 220 yd.), 2 ft., 6 in.; 400 meter (or 440 yd.), 3 ft.

Modern hurdling style calls for the runner to race directly at the hurdle, jump over it with a long, extended stride, and clear it in such a manner that he is able to snap his lead foot down to the ground quickly in order to resume running speed as rapidly as possible. The high hurdles are the truest hurdles test. Good sprinters can often turn in first-class performances in the low hurdles. Alvin Kraenzlein, Forrest Towns, Fred Wolcott, and Harrison Dillard were outstanding in both low- and high-hurdle competition.

INTERNATIONAL NEWS PHOTO

*Contestant going over the bar in a high jump*

### JUMPING

**High Jump.** In high jumping, the athlete jumps over a horizontal crossbar suspended between two upright poles. It is properly divided into the running high jump and the standing high jump, although the latter event, once very popular and for years a part of the Olympic program, is no longer included in regular track and field competition. Unlike the standing high jump, in which the jumper propels himself over the bar from a standing position, the running high jump permits the contestant to run towards the crossbar from any direction and at any speed, and thus gain added momentum before he propels himself upward from the ground. The most successful method of jumping is the Western layout, or "Western roll," in which the jumper, running at moderate speed, approaches the crossbar at a 45° angle, springs upward from the leg nearest the bar, turns the front of his body toward the bar as the length of his body "rolls" over it, and lands on his hands and knees. The jump is measured from the ground to the central point of the crossbar. Phenomenal results in high jumping were achieved by Lester Steers, an American, whose heavy, muscular physique contrasted sharply with the slighter stature of other jumpers. He is said to have jumped over 7 ft. in practice.

**Broad Jump.** Jumping for distance is one of the oldest track and field events, and was included in the ancient Greek games. The once-popular standing broad jump, an Olympic event for many years, is seldom held today, but the running broad jump is held in most meets. The contestant races down a narrow cinder runway in such a manner that he touches the takeoff board at the end of the runway with his leaping foot while running at top speed. From the takeoff board, which is 8 in. wide and set flush with the ground, he propels himself through the air and lands in a specially prepared pit. The jump is measured at right angles from the edge of the board nearest the pit to the nearest point from that line touched by the body or clothing of the jumper.

Leaps of over 25 ft. are common. Most great broad jumpers are sprinters who take advantage of their great speed to gain momentum for their leap. The greatest of all broad jumpers, Jesse Owens, also set world records in the sprints.

**Hop, Step, and Jump.** The running hop, step, and jump is an event seldom seen in the United States except for A.A.U. and Olympic competition, although it has a long tradition and is said to have been extremely popular in Ireland during the 19th century. It is similar to the running broad jump in runway, jumping pit, method of approach, and measurement, and in the fact that sprinters usually excel at it; it is different in that distances achieved often exceed 50 ft. At the end of his approach run, the contestant leaps off one foot, lands on that foot, takes a long step to the other foot, and then jumps as in the broad jump. The United States has not won this event at the Olympics since 1904. A standing hop, step, and jump was once an Olympic event.

JACK FRANK—HERALD TRIBUNE

*POLE VAULT*

**Pole Vault.** Pole vaulting is derived, it is believed, from an early English custom of vaulting across narrow streams with the aid of a long stick. Vaulting for distance became a common sport, to be succeeded in time by vaulting for height. The modern pole vault combines elements of the broad jump and the high jump, and adds its own distinctive element, the pole. The contestant, carrying a long pole of bamboo, aluminum, or some other strong, light material, races down a narrow runway at top speed, thrusts the pole into a wooden slot set in the ground beneath the crossbar, and with the aid of the pole and the momentum gained from the run lifts his body up and over the crossbar.

The greatest of all pole vaulters was Cornelius Warmerdam, an American, who vaulted 15 ft. or higher consistently at a period when no other vaulter could reach the 15-ft. height. It was more than ten years after Warmerdam's first 15-ft. vault before another athlete, the Reverend Robert Richards, was able to reach that height.

## THROWING

**Discus Throw.** Throwing the discus, a flat, platter-like disk, is one of the traditional events, surviving pieces of Greek statuary indicating that it was a popular sport in ancient Greece. Such statuary indicates that the Greek discus thrower threw the discus with a straight, forward, underhand motion. A similar style was used in modern discus throwing until just before 1900, and apparently never produced a throw of much over 100 ft. Around 1900 the use of a preliminary turn to gain momentum was introduced, and the athlete was allowed to move about within a 7-ft. circle. Later, the circle was enlarged to 8 ft., 2½ in. Performances improved rapidly after the introduction of the preliminary spin within the circle, and records today approach 200 ft.

The modern discus is made of wood encircled by a metal rim, and inset with a brass plate in its exact center. The diameter of the discus is at least 8⅝″, and its weight at least 4 lb., 6.4 oz. The discus must be thrown in a specified 90° sector, and the distance of the throw is the distance from the nearest point of the circle to the nearest point on the ground touched by the discus on landing.

Although his records can not compare with present-day marks, Martin J. Sheridan of the United States, who competed in the early 1900's, must be considered one of the greatest of all discus throwers. He won three Olympic titles and held a succession of world records for a decade.

**Hammer Throw.** It is thought that hammer throwing began in Ireland, where laborers in friendly competition with one another, strove to see which could throw the large sledge hammers they worked with the furthest distance. Later, the pastime developed into an organized event, and the hammer evolved from an angular metal head on a rigid wooden handle into today's round metal ball suspended at the end of a steel wire, with a loop for the contestant to grip with both hands at the other end. The ball, with handle, must weight 16 lb., and the overall length must not exceed 4 ft. The hammer is thrown from a circle that has been reduced in diameter through the years to its present 7 ft.

The contestant stands in the circle, swings the hammer around his head and shoulders several times, and then turns his body with the swing of the hammer two or three times to gain maximum centrifugal force before releasing the weight. The ball must fall within an indicated 90° sector.

The "Golden Age" of hammer throwing in the United States was the early 1900's, when the famous "Irish whales," big, strapping Irish-Americans like John J. Flanagan, Matthew J. McGrath, and Patrick J. Ryan took turns holding the world record and winning the Olympic title. In recent years European athletes have dominated the event.

**Weight Throw.** In weight throwing, the contestant lifts and throws a standard-sized weight, usually for distance, although in the past some weight-throwing contests were held in which the weight was thrown for height over a crossbar. The origin of weight throwing is obscure, but it has been determined that a form of weight throwing was a sporting event in Ireland before the Christian era. Today, it is held occasionally, usually only in large championship meets. It is no longer an Olympic event.

Two sizes of weights are used in modern competition, one of 35 lb., the other of 56 lb., both weights including the handle. The weight itself is a metal ball to which is attached the point of a triangular metal handle. The weight

is thrown from within a 7-ft. circle, and must land in an indicated 90° sector. The contestant stands with his back in the direction he will throw, holds the weight by the handle with both hands, and swings it a few times in front of him to gain momentum. He then makes one swift, complete turn of his body, swinging the weight around and up over his shoulder, where he releases it. As in the hammer throw, the peak of weight-throwing activity in the United States was in the early twentieth century.

**Javelin Throw.** The javelin throw has its origin in the hurling of a spear in primitive warfare or hunting. The javelin used in modern contests is a light wooden shaft with a metal point; all-metal javelins have been allowed in some meets. The javelin must be at least 8½ ft. long and must weigh at least 1¾ lb. At the center of gravity, which is forward of the middle point of the javelin, there is a grip of tightly wound cord. The contestant holds the javelin by the grip and runs rapidly up to a line, behind which, however, he must release the shaft. If the javelin breaks in mid-air, the throw does not count. In a good throw, the point of the javelin must strike the ground before any other part. The greatest javelin throwers in modern track and field competition have usually been Finnish or American. Marks of well over 250 ft. have been achieved.

INTERNATIONAL NEWS PHOTO

*Champion javelin thrower in full action*

**Shot Put.** In putting the shot, the athlete stands within a 7-ft. circle, holds a heavy weight in one hand, and propels it outward through the air. The distance of the put is measured from the circle to the nearest point the shot touches as it falls. The sport is probably derived from simple stone-throwing contests. The modern event came from Ireland and Scotland, and is a traditional part of the track and field scene. The modern shot is a metal ball weighing 8, 12, or 16 lb. The 8-lb. shot is rarely used, except in women's competition; the 12-lb. shot is standard in high-school meets; the 16-lb. shot is the size used in most meets above the high-school level, including the Olympic Games.

In putting the shot, the contestant holds the shot against his shoulder or neck, keeping it from going behind or below the shoulder. He springs forward off his rear leg and simultaneously leaping and straightening his legs, trunk, and arm, thrusts the shot forward. Because of the complicated motions of the legs, trunk, and arms, excellent co-ordination is required of the championship shot putter.

Americans have always been outstanding in this event. In 1909 Ralph Rose, an American, became the first to put the shot over 50 ft. In 1954 Parry O'Brien, another American, became the first to exceed 60 ft.

### DECATHLON

The decathlon is a 10-event program for individuals, generally held over a two-day period, with the contestant compiling the best point score for all 10 events declared the winner. The events are the 100-, 400-, and 1,500-meter runs; the 110-meter hurdles; the shot put; the discus throw; the javelin throw; the broad jump; the high jump; and the pole vault.

INTERNATIONAL NEWS PHOTO

*PUTTING THE SHOT*

A norm is established for each event for which a value of 1,000 points is given. An individual's score in each event is based on a comparison of his time or distance with that of the norm, and points are assigned accordingly.

One of the most strenuous of all athletic endeavors, the decathlon is seldom held except for national or Olympic championships. It is nevertheless one of the most respected of all athletic contests. Jim Thorpe, the American Indian athlete, won the Olympic decathlon with a great performance in 1912, only to have his title taken from him later on when charges against him of professionalism were upheld. The only other athlete to compare with Thorpe in the decathlon was another American, Bob Mathias, who won the Olympic decathlon in 1948 and 1952, and the American national decathlon championship four times. *See also* Olympic Games.

T. F. H. and R. W. Cr.

**TRACTARIAN MOVEMENT,** a name sometimes given to the Oxford Movement, a religious revival in the 1840's in the Church of England. The name is derived from *Tracts for the Times,* published by leaders of the movement between 1833 and 1841. *See also* Oxford Movement.

**TRACTION, ELECTRIC.** *See* Electric Traction.

**TRACTOR.** *See* Farm Machinery; Motor Vehicles.

**TRADE AGREEMENTS, INTERNATIONAL.** *See* International Loans and Agreements.

**TRADE AND EXCHANGE IN THE U.S.** Commerce arises mainly from regional economic differences. Such differences between the Orient and Europe, first fully realized in the late Middle Ages, stimulated a search for an easier route to the Orient, and this search disclosed the New World as a rich source of precious metals to replenish the depleted European stocks. A lively trade began between the Old and New Worlds, natural wealth moving eastward in exchange for manufactured goods moving in the opposite direction. Coastwise trading also developed between the northern colonies and those along the southern shore of North America and in the West Indies, based on product variety due to climatic differences. At first there was little domestic commerce. Naturally inclined toward self-sufficiency and hampered by lack of currency and of decent inland transportation, the colonists limited their local trading to the veriest essentials.

**Commercial Development of the United States.** The American Revolution (1775-1781), the Napoleonic Wars, and the War of 1812 seriously interfered with both overseas and coastwise trade. The United States was forced to rely largely on its own resources. Westward movement across the mountains, both in the north and in the south, opened up new regions whose products and needs were different from those of the settled areas along the eastern seaboard. For a time industry continued to be local. Grist mills, forge shops, tanneries, and the like were situated close to their raw materials and sold their products only in the immediate neighborhood. Agriculture was fairly general in character and was carried on largely for the pioneer farmer's own consumption. As trade developed, industries became more centralized and specialized, while markets broadened and the standard of living increased. Foreign trade also increased, although it failed to keep pace with the rise in domestic trade. In addition, the young nation was more dependent on imports of European manufactures than were foreign markets on agricultural products which constituted its only exportable surpluses. In consequence, its private financial debt to foreigners increased. It also experimented with protective tariffs as a means of fostering domestic industry.

*Industrial Growth.* The Civil War (1861-1865) had dramatic impact on the economic, as well as the political and social, life of the nation. The war induced a series of currency and price convulsions, but in its wake there followed great improvement of transportation, financial, and trade facilities. Development of the railway network, of the National Banking System, and of public trading in corporate securities during the last four decades of the nineteenth century accelerated the rate of industrialization, wove the country's myriad threads of economic power into the fabric of one vast market and stimulated unprecedented growth of domestic trade. Development of electric power, mass production techniques, and automotive transport brought it to the forefront in both agriculture and manufacture. Introduction of the Federal Reserve System in 1913 markedly improved the country's currency and credit facilities, although the financing of World War I (1914-1918) expenditures brought on inflation which later bore bitter fruit. A primary postwar recession was followed by eight years of industrial and commercial prosperity in which the credit policy of the new banking system prevented commodity prices from getting out of hand. In the later stage of this period, however, stock speculation got beyond the control of the Federal Reserve System and culminated in three years of collapse into abysmal depression. Price deflation and trade stagnation brought on reform of the money system, of banking practice, and of trading in securities. Federal regulation became a dominant policy.

*Effect of World War II.* American exports during World War I had been so great that the nation's international financial position shifted from that of debtor to that of creditor. The first demands of Great Britain and France in World War II revived trade in 1939. As the United States gradually increased its participation in the conflict and finally became a full-fledged belligerent in 1941, agricultural and industrial production soared. Trade volume, both domestic and foreign, increased rapidly and its commodity pattern changed as the nation mobilized for total war. The government's astronomical expenditures were financed in a manner somewhat less inflationary than in the preceding war. Such inflationary pressure as did bear on commodity prices was held in check by price control and rationing of both producers' and consumers' goods. With the close of the war in 1945 and relaxation of government controls, both domestic and foreign trade volume rose to new heights, and prices began a steep ascent, reaching a plateau in 1954.

### PRICES

Under a strict barter system the value of a good could be fully expressed only by citing the quantities of each and every other good for which the first good might be exchanged. It may thus be appreciated that a medium of exchange enormously simplifies the whole process of valuation. Whether or not money actually changes hands in the act of trading, the monetary unit acts as a common denominator, and the value of a good expressed in terms of money is called its price. Price is such a familiar concept that its meaning might seem too obvious to merit comment. Yet any discussion of this most significant phenomenon in the process of trade and exchange is faced at the outset with certain difficulties which must be cleanly disposed of if confusion is to be avoided. One might cite the price of a certain good as $20,000. If the good were, say, an indivisible and unique object such as a statue, this would be the most convenient way to express its price. If, on the other hand, the good were a 100-acre tract of land, the price might be more significantly expressed as $200 per acre. With some goods, furthermore, price is conventionally expressed the other way around, as so many yards or ounces or other physical unit per dollar. These difficulties and other similar ones are trifling when individual transactions alone are under consideration. Misunderstanding can be avoided by the simple expedient of stating the terms of trade clearly. When it is necessary, however, as in making historical comparisons, to contemplate whole masses of transactions in many goods in many markets at different times, price representatives must be devised statistically with care to insure internal consistency and external comparability. Construction of such representatives are called price index numbers.

**Historical Price Comparisons.** Historical price comparisons are of two types. The first has to do with general movements of prices to a higher or lower level. Such movements may continue gradually through many years but are usually moderated by shorter cyclical movements and sometimes interrupted by sharp gyrations. They manifest changes in the value or purchasing power of money, in the relation between debtors and creditors, and often in the character

of commercial activity. The second, nearly always closely related to the first, deals with changes in the internal structure of prices; that is, in the relations between the prices of different goods. Such changes bear directly upon the distribution of income and upon the allocation of resources to different lines of production. Wages are the price of labor, rent the price of the use of land, and interest the price of the use of capital. Pure profit, the share of the entrepreneur, and taxes, the share of government, are not prices, since neither is proportioned to the goods or services given in exchange. This article deals with certain important samples such as wholesale commodity prices, the cost of living, security prices, and selected interest rates; for these there exist reliable data covering a considerable period of years.

**Wholesale Commodity Prices.** *Pre-Civil War Period.* The first major convulsion of commodity prices followed the expiration of the Bank of the United States' charter in 1811. Overissuance of notes by state banks and unsound government financing of the War of 1812 sent wholesale prices soaring 50 per cent. A crisis occurred shortly after the close of the war early in 1815, and within a few months prices fell back to the prewar level. American manufactures, which had been protected by the embargo, were again exposed to foreign competition. Effective tariff protection was given only to the textile and iron industries. The continuing currency inflation affected principally the value of bank stocks and real estate. Commodity prices generally failed to rally, and when the Cheves administration of the Second United States Bank began deflating the currency in 1819, they resumed their decline. Thus began a long downward trend. Brief upward flurries during the early 1830's invariably gave way to recession. That commodity prices did not break early in the 1837 depression was attributable to loans of gold and silver from British banks which made it possible for commodity speculators (including the Second Bank of the United States, then operating as a private institution under a Pennsylvania charter) to maintain their unsound positions. When these loans were called in 1839, wholesale prices immediately slumped. In 1849 they reached a bottom 62 per cent below the 1814 peak and 43 per cent below the 1812 level. After the California gold discovery the inflow of precious metal provided a large increase in the reserve for paper money and sent prices sharply upward in 1853. Precipitated by a banking crisis in New York State, however, a recession developed in 1857, taking prices back to the earlier level, where they stayed through 1860.

*Civil War and Reconstruction Period.* During the Civil War the huge military demand for a wide range of commodities and the government's inflationary financial policy caused wholesale prices to mount rapidly. In the immediate aftermath of the war national bank notes, backed by fractional reserves of greenbacks, added to the inflationary spiral. Altogether, prices rose 114 per cent from 1860 to the peak in 1865. A sharp setback occurred in 1882 and another in 1885. Agricultural commodity prices in particular were deeply depressed, and grotesque maladjustments developed within the price structure. Kansas farmers burned their corn in preference to wood or coal because the corn was cheaper. Another peculiarity about the latter half of the 1880's was that, while there was considerable resurgence of business prosperity, commodity prices in general did not appreciably rise, and many individual prices continued inexorably to decline into the depression of 1890-1891. A brief rally, prompted by the effects of the McKinley Tariff Act and the Sherman Silver Purchase Act, was wiped out as the country experienced a panic in 1893. Repeal of the Sherman Act had a depressive effect, and the threat of the free-silver advocates to pass another act led to a heavy drain on the country's gold reserves. In 1896 wholesale prices finally reached their nadir, 67 per cent below the 1865 peak and 27 per cent below the 1860 level.

*Beginning of Recovery.* In 1897 a good wheat crop in the United States, with poor crops abroad, made possible large exports at high prices. Agricultural prices in general turned upward and carried with them the prices of foods. Those of textiles, fuels, metals, and building materials, on the other hand, fell off slightly. By 1900 a general upward movement of prices clearly was under way except among the metals, which were receding from a high point produced by the demands of the Spanish-American War.

The rising trend was very moderate, but it persisted, being interrupted only slightly by the financial panics of 1903 and 1907. Throughout the entire period from 1896 to 1914, indeed, the only important price fluctuations were in securities and real estate, rather than in commodities.

*World War I Inflation.* The outbreak of World War I in Europe was not significantly reflected in United States commodity prices for some time. Even as late as 1916 the only sharp increases were in the fuels and metals. In 1917, however, the effects of military demands and inflationary financing began to be clearly felt in the commodities markets. Farm product prices rose most steeply, carrying food prices along with them. Among industrial products the metals, fuels, and textiles registered the sharpest advances. The year 1918 saw a continuation of rapid increase in farm-product prices, but food prices rose more moderately. Of other leading commodity prices only those of the textiles continued to soar, while those of the metals actually dropped with some abruptness. In 1919, the first year after the close of hostilities, textile and fuel prices fell off somewhat, and those of the metals continued their decline. Farm-product and food prices rose moderately. A resurgence of peacetime demands sent the prices of building materials up sharply. Agricultural-product prices turned downward in 1920, and other prices probably would have followed suit but for certain measures taken by the government, ostensibly to facilitate reconstruction in Europe and advancement of foreign trade, but at least equally motivated by the hope of forestalling dread deflation, depression, and unemployment. New loans were extended to European countries. The merchant shipbuilding program begun during the war was continued. Leftover stores of merchandise, which had been purchased as military supplies, were locked up in storehouses rather than dumped on the market. To finance these measures the government continued to borrow heavily, and the Federal Reserve System maintained artificially low interest rates in order to facilitate flotation of the bond issues. As a result, practically all industrial commodity prices leaped rapidly upward, the fuels, house furnishings, and building materials leading the advance. Some indication of the distortions and strains which wartime and postwar inflation produced in the internal structure of prices is given by the following percentages of 1915-1920 increase: all commodities, 122 per cent; all farm products, 120 per cent; all industrial products, 132 per cent; foods, 111 per cent; textiles, 205 per cent; fuels, 215 per cent; metals and metal products, 73 per cent; building materials, 182 per cent; house furnishings, 154 per cent.

*Readjustment and Recession.* The expedients intended to avoid inflation merely postponed the evil day. When prices finally broke at the end of 1920 the drop was precipitous, the 1921 decline for all commodities averaging 38 per cent. Deflation brought some readjustment of price relationships,

the largest declines being registered in those commodities whose prices had risen most in the inflation; but the realignment was by no means complete. During the next eight years a moderate amount of general prosperity was punctuated by mild recession in 1924 and 1927. Wholesale prices moved irregularly without pronounced trend either upward or downward. Farm-product and food prices were slightly higher in 1929 than in 1921, but those of practically all other important products were a little lower. The prosperity of the twenties, manifested in the 1928-1929 boom and the New Era philosophy, was largely a financial phenomenon not reflected in commodity prices. The three-year business recession which began in mid-1929, however, was reflected in a rather steep decline of commodity prices. For most commodities the slump was fairly even and regular, although house furnishings fell off only a little, and building materials actually rose slightly, during the first year. For all commodities taken together the three-year descent of wholesale prices amounted to about one third. The 1932 low point was 58 per cent below the 1920 peak and 7 per cent below the prewar level. Although the 1929-1932 episode was merely a final reaction to World War I inflation, its impact on the various commodities not only differed widely but also failed to compensate for the differences in impact of earlier phases.

Ascent from the 1932 low point was at first slow and irregular. As a result of the government's agricultural program, the prices of farm products and of foods began to increase rapidly in 1934 and 1935, but the rise tapered off in the next two years. During the same period industrial-product prices continued to ascend irregularly and more slowly. A recession in the latter part of 1937 brought about a sharp setback in the prices of farm products and of foods. In other commodities the preceding rise had been less pronounced, and the reaction was milder.

*Effect of World War II.* The outbreak of World War II in Europe did not immediately have any great effect on American wholesale prices. After 1940, however, farm-product and food prices soared almost as steeply as in the corresponding 1917-1918 period. Other commodity prices also rose, but somewhat more moderately. The fundamental causes of these price increases, of course, lay in the astronomical demands for commodities to supply both our own rapidly expanding military forces and our allies under Lend-Lease, and in the inflationary manner by which the government financed its purchases for these purposes. Governmental controls of prices and consumption began to take effect on industrial products, except foods, late in 1942 and on farm products and foods late in 1943. It is clear that the 1940-1946 over-all increase was about 54 per cent. While this was less than in the preceding war, the dispersion of impact on particular commodity groups was at least as great, as is indicated by the following figures: all farm products, 120 per cent; all industrial products, 43 per cent; foods, 82 per cent; textiles, 58 per cent; fuels, 26 per cent; metals and metal products, 21 per cent; building materials, 40 per cent; house furnishings, 26 per cent. During the early part of 1947, furthermore, the wholesale prices of all commodities and of farm products, foods, and building materials, in particular, continued to rise steeply. This rise continued until 1954, by the end of which year the wholesale prices of all commodities were 10 per cent above the 1947-1949 average. However, farm products and textile prices had begun to decline and were 3 per cent below that average.

**Cost of Living.** The modern concept of the cost of living is a composite of the retail prices of food, clothing, fuel, household furnishings, and the like, weighted by the proportions which these elements constitute in the budget of some "typical" family, usually one of low income. Reliable index numbers of the cost of living thus conceived do not date far back into American history. Lack of such indexes for earlier periods, however, is not particularly serious, because they would be of doubtful value in any event. With the growth of cities and towns in the United States, a steadily growing proportion of the population became increasingly dependent, and aware of its increasing dependence, on the prices of necessity goods. In the inflation of World War I and its immediate aftermath, living costs rose about 98 per cent. Popular cartoons personified "Old Man H.C.L." (high cost of living), and his villainy became the subject of bitter jests. In 1921 the cost of living fell back about one-ninth from the 1920 peak and remained at about that level, with little variation, through 1929. In the recession which followed, it declined to a low point in 1933, about 35 per cent below the 1920 peak, but 28 per cent above the prewar level. It increased very slightly during the 1930's. In the early part of World War II it began to ascend almost as steeply as in the corresponding period of the preceding war, the 1940-1943 increase being about 23 per cent. Government price control and rationing then held it fairly steady until the close of hostilities. When wartime controls were relaxed, another rapid rise began. The cost of living was 43 per cent above the 1940 level in 1946. In the latter part of 1948 and throughout 1949, there was a gradual decline, but in 1950, with the outbreak of the Korean War, the cost of living began to rise again, reaching a peak 15 per cent higher than the 1947-1949 average early in 1954.

**Stock and Bond Prices.** The prices of corporate securities first began to assume some significance in the economic scene after the Civil War. Prior to that time there had been a certain amount of public trading in bonds of the Federal government and of state-sponsored internal improvements, and even in bank stocks, in a small way, on the organized exchange in New York City. It was not until the era of large-scale railroad construction and finance, however that fluctuations in the prices of corporate securities became a noticeable factor in commercial affairs. Railroad stock and bond prices played some part, though minor, in the events leading up to the crises of 1873 and 1884 and in the recessions which followed.

During the last quarter of the nineteenth century bond prices followed a generally upward trend, with little variation. This trend was popularly regarded as the natural result of declining commodity prices. Stock prices, on the other hand, exhibited a slight downward tendency, commonly attributed to the same declining trend of commodity prices. More important than this long-run trend, however, was the inclination of stock prices to fluctuate over a wider range than bond prices. Stock prices, for example, passed through great cycles of ascent and descent in the periods 1877-1885 and 1886-1893. These movements reflected the susceptibility of ownership shares to the influence of cyclical change in business activity.

*Swing Toward Speculative Issues.* Toward the end of the nineteenth century security buyers began to turn away from high-grade, low-yielding railroad bonds and to show a preference for more speculative securities which, if fortune favored, might produce a larger return. Demand increased for stocks, industrial bonds, and second-grade railroad bonds. The high-grade bond price trend did not turn definitely downward until after the 1903 recession, but stock prices began to move steadily upward as early as 1897. The upturn of commodity prices, the settlement of the silver issue, the cor-

porate consolidation movement, and the influx of gold from Alaska were all factors in establishing the new trend. During the wartime commodity price inflation of 1915-1920, bond prices drastically declined. Stock prices, however, did not show the opposite tendency. They gyrated rather widely and reached peaks in 1916 and 1919, but they subsequently receded to such an extent that in 1920 their level was virtually the same as that of 1902.

*Collapse and Depression.* In the business recession and commodity price collapse of 1921, bond prices rose and stock prices declined, true to the earlier theory, but neither movement was precipitate. The paradox that bond prices plodded steadily upward through 1928 while the stock market was engaged in a period of skyrocketing prices is explained by the fact that while Federal Reserve policy succeeded in producing easy money conditions, it failed to keep bank credit out of the speculative arena. In the climactic year 1929, however, the Reserve System permitted the discount rate to be raised, and bond prices fell off slightly while stock prices were climbing to their peak. During 1930-1931 bond prices rose a little as stock prices tumbled from the heights. The black despair of 1932, however, produced a reaction in the bond market which was almost as severe, relatively speaking, as the last sickening plunge of the stock market, although it did not carry bond prices as far down as the 1921 low point. During 1933-1936 both stock and bond prices recovered rapidly, the latter achieving a new all-time high, but they both leveled off in the business setback of the following year.

*Gradual Recovery.* Beginning with 1938 the Federal Reserve System's easy money policy was again reflected in a slow but steady advance of bonds, right on through the period of wartime commodity price inflation, to still higher record prices, an advance which continued until May 1952. In 1952 the Federal Reserve System relaxed its easy money policy and bond prices declined slightly. Ownership shares, on the other hand, evinced signs of increasing, rather than decreasing, price instability. Trading restrictions imposed by the Securities and Exchange Commission produced a "thin" market in which prices dropped abruptly in 1938, even on a comparatively small volume of trading, recovered slightly in 1939, and then fell off during 1941-1942 almost to the 1921 level. From this low point they leaped upward in 1943 but then moved irregularly until the end of the war. During the early postwar years, stock prices failed to respond to the increased earnings of corporations. However, expectations of a postwar depression did not prove correct, and stock prices began to rise slowly in 1952, rapidly in 1954, and by early 1955 surpassed the high level which had been established in 1929.

**Interest Rates.** Since 1875 interest rates have passed through a complete long cycle as well as several minor fluctuations. The average yield, or effective interest rate (that is, the rate of return to an investor buying at the current price and holding to maturity), on high-grade corporate bonds in 1876 was about 6½ per cent. In 1931 the average effective rate in corporate bonds stood at its prewar level of 4½ per cent, that in long term government bonds at 3½ per cent, and that in short-term government bonds at about 2½ per cent. The yield in the more sensitive short-term obligations fluctuated the more widely, being above that on long-term bonds during 1919-1923, below during 1924-1925, above during 1927-1929, and below from then on. In 1932 all yields rose sharply, but from that point forward they descended, almost without interruption, for a decade and a half, in spite of inflationary pressure during and immediately after World War II. In 1946 the average yield on high-grade corporate bonds was about 2½ per cent. On long-term government bonds it was about 1½ per cent and on short-term government bonds about 1 per cent. During the postwar years, Federal Reserve and Treasury policy allowed interest rates to rise somewhat, and in 1955 the rate on long-term government bonds was about 2.65 per cent, that on short-term government bonds 1 per cent, and that on high grade corporate bonds 3½ per cent.

## TRADE VOLUME

**Measurement.** Comparison of trade volume in different goods, different markets, and different times poses a problem which is partly conceptual and partly factual. Trade volume is sometimes gauged by the quantity, measured in physical terms, or by value of commodities entering into exchange. Quantity is measured at the point of production and, in effect, implies only one exchange. But a pair of shoes, for example, gives rise to a great deal more trade volume if it passes, as often at present, through the hands of a jobber, a wholesaler, and a retailer on its way from manufacturer to consumer than if, as in Colonial times, the shoemaker sells directly to the consumer. Counting the shoes only once and evaluating them at manufacturing cost understates not only by ignoring subsequent transactions in which they may figure but also by ignoring distribution costs. Such a gauge makes little allowance for services paid without exchange of commodities and none at all for sales of securities, land, and the like. The concept, unfortunately, cannot be summarily discarded. It is the only one for which there exist comprehensive data on trade prior to the twentieth century. Statistics expressed in these terms probably are not seriously deceptive when the reference is to earlier times, in which distribution and financial mechanisms were much simpler. Their significance and comparability rapidly diminish, however, as the mechanisms grow more complex.

Another means of judging trade volume is by the total quantity of money payments. Such a measure is much more comprehensive than that described in the preceding paragraphs. It is therefore more useful in depicting the over-all relationships among money, credit, prices, and trade. It is defective, however, in that it cannot be analyzed in order, for example, to compare trade in different commodities. Such data, furthermore, are not available for years prior to the twentieth century.

Nothing can really take the place of data on the specific kinds of trade it may be desired to examine and compare. These aspects necessarily are somewhat fragmentary. Retail trade, for instance, constitutes only about 5 per cent of total money payments. Here, too, some of the important statistical data do not date back many years. On the other hand, this manner of approach has the advantage of representing, more closely than any of the other concepts, the ordinary person's idea of trade.

**Pioneer Trade in the United States.** Until well into the nineteenth century domestic trade in the United States was of a rudimentary sort. Farmers of the eastern seaboard usually hauled their produce to the nearest local market for sale directly to consumers, or to the nearest seaport for shipment overseas. Manufacturing establishments, engaged mainly in processing agricultural products, were small and sold most of their wares directly to local consumers. Money was scarce, and much of the trading was an exchange of goods for goods or for credit which was later discharged in goods. Pioneers who crossed the mountains in the first stages of the westward movement were forced by circumstances to

live in almost complete self-sufficiency. They could scarcely produce enough to meet their own needs, and having little surplus to sell, they had little wherewithal to buy. In any event, the cost and hazard of transport virtually precluded trade with the East. A few commodities, such as furs, were valuable enough, in proportion to their bulk, to stand the cost of carrying them out by packhorse or wagon. A little livestock could also be sent east, since it lived off the land and provided its own transportation. These were exchanged in the East for commodities, such as firearms, which the pioneer simply could not produce for himself and which could stand the high cost of westward shipment by wagon.

**Factors in Trade Development.** *Transportation.* To the limited extent that surpluses of bulkier products such as grains were available in the West, they were shipped by barge down the Ohio and Mississippi rivers to New Orleans for transshipment to the East or overseas. Since upstream navigation could be accomplished only by keelboat, arduously propelled by human power, the grain seller usually sold his barges also and made his way back north with the proceeds of his marketings in the form of money rather than provisions. Advent of the steamboat on the western rivers about 1815 not only solved the problem of upstream navigation but also reduced the cost and time of shipment downstream. As a result, commerce between the North and South in the West increased something like tenfold in twenty-five years. Construction of canals, particularly the Erie Canal which was opened in 1825, greatly reduced the cost, time, and hazard of transportation between the eastern seaboard and the region just south of the Great Lakes. There followed a rapid growth in the quantity of cereal, animal, and forest products moving North and East out of the interior to Lake Erie and thence via the Erie Canal and Hudson River to New York City. Westbound shipments consisted mainly of clothing, hardware, machinery, medicines, coffee, and sugar. Most revolutionary of all in its eventual effect on domestic trade was the introduction of the steam railroad in 1830. At first, however, the railroad companies had grave difficulty raising necessary capital, due to popular distrust based largely on ignorance and prejudice. They met with considerable opposition, furthermore, from the canal companies and other vested interests. For these and a variety of other reasons, the new mode of transport was slow in developing. Improvements in transportation brought about some widening of markets, but almost equally significant was the evolution of better marketing methods, particularly for manufactures. The census of 1840 reported 57,565 retail stores, over half of which were located in New York, Pennsylvania, Virginia, Ohio, and Mississippi. As late as the middle of the century, however, the total volume of domestic trade still was small. Secretary of the Treasury Robert Walker, in his report for 1847-1848, estimated the value of the country's annual output at $3,000,000,000, of which he judged that $500,000,000 worth was "interchanged between the states of the Union." In a report to Congress in 1853 Israel D. Andrews estimated that the total volume of internal freight traffic totaled $1,461,000,000, of which 41 per cent was carried on the canals, 37 per cent on the railroads, and 11 per cent each on the Great Lakes and rivers. This total is not comparable with Walker's trade figure because it includes some local as well as interstate commerce. It also includes duplication of goods carried successively by two or more means of transport. Nevertheless, both figures significantly indicate that at that time, in contrast with the present, only a fraction of the country's products entered into trade beyond the immediate locality. The last half of the century was characterized by a vigorous growth of domestic trade.

*Industrialization.* Reduction of transportation costs promoted geographic specialization and gave great impetus to industrialization, the second important factor in the growth of trade during this period. Before the Civil War rail shipment for any distance more than a few hundred miles had been restricted to valuable, high-grade commodities of small bulk. As it became practical to ship lower-grade commodities long distances by rail, the old inland water routes, such as the Erie Canal and the Mississippi River, were largely superseded by new rail and rail-water routes. From the eastern and central South cotton, lumber, and tobacco moved in large volume to the manufacturing region in the Northeast. To the eastward flow of rail traffic grain and flour were contributed by the Middle West, livestock and petroleum by the Southwest, minerals by the Rocky Mountain area, fruit by the south Pacific region, and lumber from the north Pacific section. Westbound traffic consisted mainly of manufactures from the Northeast. Industrialization of this region was augmented not only by the reduced cost of transporting raw materials and finished products but also by protective tariffs, which enabled American manufacturers to capture the domestic market from their European competitors. An important new trade route was that by which grain and iron ore moved out of the northern Minnesota and southern Canada region, at the head of Lake Superior, by steamer down the Great Lakes to Lake Erie ports and thence by rail to the Pittsburgh area and the eastern seaboard. Much of the return cargo consisted of coal shipped from West Virginia by rail to the Lake Erie ports and thence by steamer up the Great Lakes.

*Finance.* A third important factor contributing to the growth of trade was the development taking place in the field of private finance. The National Banking System, though imperfect in some ways, went a long way toward remedying these difficulties. Evolution of the corporate form of business organization, of investment banking, and of trading in corporate securities on organized exchanges further enhanced the flow of capital into industrial and commercial companies. On the other hand, financial activity, public as well as private, at times had adverse effects on trade.

*Improved Marketing.* A fourth factor consisted of changes in the marketing mechanism. In wholesale trading the changes involved, not invention of new institutions, but tendencies of trade to concentrate in certain large cities, which became specialized as marketing centers, and to become simpler through eliminating or by-passing superfluous middlemen. Along with the increase in the scale of manufacturing, there developed mass-production methods and product standardization which usually made it possible for the manufacturer to sell directly to the wholesaler and often to the retailer or even to the consumer himself. Establishment of produce exchanges in several of the larger commercial cities during this period helped smooth out the seasonal and other irregularities in the flow of agricultural and mineral products from producers to processors. In retail trading the peddler practically disappeared and the pre-eminence of the general store began to be superseded by the specialty store, the department store, the mail-order house, and the chain store. These new types of retail outlet represented a kind of specialization and widening of the market in that they afforded consumers, particularly in formerly inaccessible rural areas, an opportunity to choose goods which more nearly suited their needs or fancies.

*Extent of Development.* For this, as for the earlier period, there exist no comprehensive statistical data showing directly the extent of growth in the total volume of domestic trade. Such indirect evidence as does exist, however, indicates that it must have been very great, in spite of the fact that the period included thirty-one years (1865-1896) of generally declining prices and two severe depressions (1873 and 1893). The National Conservation Commission in 1915 estimated the volume of trade for the last half of the nineteenth century as follows: 1850, $2,000,000,000; 1860, $3,500,000,000; 1870, $5,000,000,000; 1880, $7,750,000,000; 1890, $12,000,000,000; 1900, $20,000,000,000. These figures might be described more accurately as the "value of goods available for trade," because they are simply the estimated aggregate value-product of agriculture, mines, fisheries, and factories, plus imports and the cost of transportation. Bogart and Kemmerer estimate that in 1860 the railroads and inland waterways carried about 50,000,000 tons of freight valued at $3,500,000,000 and that in 1914 they carried about 2,000,000,000 tons valued at about $30,000,000,000. These figures, of course, exclude strictly local trade. It does not seem unreasonable to say that between 1850 and 1900 the total volume of domestic trade increased something like tenfold.

**Twentieth Century Progress.** Domestic trade volume continued to expand during the twentieth century. There was considerable change, however, in the relative importance of the various factors contributing to the expansion. Industrialization proceeded apace. Integration of production facilities and standardization of products paved the way to larger scale mass-production at lower cost. Advancement along this line was fostered by industrial research and the invention of new processes. Development of electric power production and of the internal combustion engine introduced unprecedented flexibility to the operations of many industries, and advances in steel production reduced the costs of construction and equipment. Agricultural production was enhanced by scientific farming. In addition, the farmer devoted most of his resources to money crops, so that commercial trading became an increasingly important phase of his activities. Mineral production increased sevenfold under the stimulus of industrial demands for coal, petroleum products, and iron ore. Between 1910 and 1953 the nation's gross national product, which is the value of goods and services produced in the economy, increased as shown in this table:

GROSS NATIONAL PRODUCT, 1910-1953
(*Billions of dollars**)

| | | | |
|---|---|---|---|
| 1910 | 85 | 1939 | 165 |
| 1929 | 105 | 1945 | 275 |
| 1932 | 101 | 1953 | 300 |

*In terms of 1947 dollars, to eliminate changes in dollar value.

These figures show the real growth that has occurred in the economy since 1910 and especially since 1940. Growth in real output of goods and services has averaged about 3 per cent per year during the twentieth century. Since 1929 real output has more than doubled, and the real output per capita has increased by almost three fifths.

*Transportation.* Improvement of transportation, while important, was by no means the major factor. Development of automotive trucks and of all-weather surfaced roads was a significant advance, but the effect was principally on local trade. The railroads had virtually completed their network before 1900. Their principal subsequent contribution to trade was an increase of freight train speeds and more extensive use of refrigerator cars, thus widening the markets for perishable goods such as fresh fruits and meat. Inland water transportation experienced considerable revival of traffic, and construction of the Panama Canal greatly added to trade between the Atlantic and Pacific regions. Introduction of air transport afforded opportunity for a dramatic increase of speed in movement of very high-grade commodities. Its excessive cost, however, limited the tonnage of freight carried by this means to almost negligible proportions.

*Finance.* In the financial field several developments affected trade. Use of the corporate form became widespread among not only industrial but also trading and other commercial firms, even those of fairly small size. The flow of capital into these lines was thus augmented, and the corporations themselves added greatly to the stream of savings through reinvestment of their earnings. Irving Fisher has estimated the volume of money payments in 1900 at $275,000,000,000 and in 1909 at $400,000,000,000. Similar estimates by Wesley C. Mitchell put the volume in 1919 at $650,000,000,000 and in 1926 at $800,000,000,000. These figures, of course, include payments for labor and other services and for real estate, securities, and the like, as well as for commodities. The effects of the minor recession in 1921, of the prosperity in the later 1920's, of the severe depression in the 1930's, as well as those of World War II show up clearly in the following Federal Reserve statistics of bank deposit debits, which consist mostly, although not entirely, of check payments.

UNITED STATES BANK DEPOSIT DEBITS, 1919-1954
(*Billions of dollars*)

| | | | |
|---|---|---|---|
| 1919 | 646 | 1937 | 635 |
| 1920 | 700 | 1938 | 551 |
| 1921 | 569 | 1939 | 577 |
| 1922 | 620 | 1940 | 611 |
| 1923 | 658 | 1941 | 740 |
| 1924 | 687 | 1942 | 848 |
| 1925 | 788 | 1943 | 1,042 |
| 1926 | 838 | 1944 | 1,163 |
| 1927 | 915 | 1945 | 1,266 |
| 1928 | 1,075 | 1946 | 1,050 |
| 1929 | 1,237 | 1947 | 1,125 |
| 1930 | 892 | 1948 | 1,249 |
| 1931 | 658 | 1949 | 1,231 |
| 1932 | 456 | 1950 | 1,403 |
| 1933 | 424 | 1951 | 1,577 |
| 1934 | 479 | 1952 | 1,642 |
| 1935 | 534 | 1953 | 1,759 |
| 1936 | 614 | 1954 | 1,887 |

In comparing the magnitudes of all the foregoing statistics, it should be noted that they reflect changes in prices as well as in the physical volume of commerce.

**Marketing Changes.** *Wholesaling.* Changes in the marketing mechanism continued along the line of the trend begun in the latter part of the nineteenth century. Independent middlemen, such as the wholesaler, became less prominent as their functions were taken over by producers. The manufacturer, producing on a larger scale, tended to establish selling departments and sales branches or agencies to deal directly with the retailer or consumer. Growth in the size of retail concerns, such as department and chain stores, furthermore, made for larger individual orders, which the manufacturer found it worthwhile to solicit directly. Of the 170,000 "wholesale establishments" reported in the 1929 census, scarcely half were independent wholesalers in the traditional sense. Total wholesale trade in 1929 was reported as $67,000,000,000, 73 per cent being in nondurable goods. Three-fifths of these nondurable goods comprised food and farm products, other leading items being dry goods, petro-

leum products, and clothing, in that order. Of durable goods which constituted the remaining 27 per cent of total wholesale trade, three-fifths consisted of machinery, metals, lumber, and other building materials, although electrical goods and automotive equipment were sizeable items. The depression of the early 1930's hit wholesale trade a heavy blow, reducing the total to $30,000,000,000. Hardest hit were the durable goods, which in 1933 dropped to one-third of their 1929 volume; the lines most severely affected were building materials, electrical goods, machinery, and metals. Even nondurable goods slumped to half their 1929 volume, however, the hardest hit being clothing and farm products. Falling prices, of course, as well as diminishing physical volume, contributed to the decline of these dollar figures. By 1940 a substantial recovery had taken place, durable goods even rising above their 1929 volume due to enormous sales of automotive equipment. Among the nondurable goods, petroleum products, coal, and coke were above their 1929 volume, as were also tobacco and liquor.

Both the size and pattern of wholesale trade in 1945 reflected the impact of war production, consumption restrictions, and price increases. The total volume, $105,000,000,000, exceeded that of 1929 by more than half. About 80 per cent of the total consisted of nondurable goods, of which food and farm products, again the leading items, made up more than half. Dry goods and petroleum products continued to be important lines. Liquor and tobacco appeared as newcomers to the "best seller" list. Trade in durable goods, which made up the remaining 20 per cent of the total, was inhibited by short supply due to utilization of production facilities for munitions manufacture during most of the year. The principal lines, however, were well over their 1929 volume. Wholesale trade expanded rapidly after 1945, and by the end of 1948 total wholesale sales had reached a total of $189,000,000,000. Important items in this growth were all durable goods lines, groceries, dry goods, and petroleum.

*Retailing.* Retail sales volume in 1929 was reported as $48,000,000,000. Nondurable goods stores handled 70 per cent of this business. Food stores led, with general merchandise stores a close second, and the two together sold three-fifths of all the nondurable goods. Durable goods establishments handled the remaining 30 per cent, of which automotive equipment stores accounted for half, and dealers in building materials and hardware one-fourth. The depression of the early 1930's dealt somewhat less severely with retail than with wholesale trade, the total volume of the former declining by about one-half. As in the wholesale trade, the durable goods were hardest hit, with all the leading lines suffering about equally. In the nondurable goods lines, apparel and general merchandise stores were hardest hit. Recovery in the late 1930's brought most nondurable goods lines back to the 1929 level, and carried filling stations and eating and drinking places well above it. Neither the general merchandise stores nor any of the durable goods establishments shared fully in this recovery, although automotive equipment stores came fairly close. The 1945 retail sales volume of $78 billion was greatly influenced by war conditions. More than 85 per cent consisted of nondurable goods. As in 1929, food stores and general merchandise stores were in the lead, the two together doing about one-third of this business, while eating and drinking establishments had become a close third. Durable goods stores, handling the remaining 15 per cent of total retail trade, suffered from restriction of supply. They actually had a smaller volume than in 1940. Dealers in building materials and hardware had the largest share, about three-eighths. Automotive equipment stores were hardly above the depression level. Jewelry was the only line which showed a substantial increase in dollar volume over that of 1929, and in this the uncontrolled rise of prices was a major factor. The 1953 retail sales volume of $171 billion reflects not only an increased price level, but also a greatly expanded physical volume of trade during the prosperous postwar years. The postwar building boom and the increased sale of automobiles are reflected in the sales of durable goods stores. In the nondurable goods stores there was a sharp increase in all lines, with food and general merchandise stores still the most important.

RETAIL STORE SALES IN THE UNITED STATES, 1929 TO 1953
(*Millions of dollars*)

| *Store Classification* | *1929* | *1935* | *1939* | *1945* | *1950* | *1953* |
|---|---|---|---|---|---|---|
| DURABLE GOODS | | | | | | |
| Automobile | 7,031 | 4,237 | 5,549 | 5,855 | 28,289 | 33,320 |
| Bldg. materials and hardware | 3,327 | 1,572 | 2,390 | 3,739 | 10,092 | 10,421 |
| Home furnishings | 2,755 | 1,290 | 1,733 | 2,740 | 8,249 | 9,125 |
| Jewelry | 536 | 235 | 362 | 997 | 1,174 | 1,452 |
| Other | 1,961 | 987 | 1,278 | 2,695 | 5,131 | 6,053 |
| Total | 15,610 | 8,321 | 11,312 | 16,026 | 52,935 | 60,371 |
| NONDURABLE GOODS | | | | | | |
| Apparel | 4,241 | 2,656 | 3,259 | 7,689 | 9,333 | 10,256 |
| Drugs | 1,690 | 1,233 | 1,563 | 3,155 | 4,166 | 4,790 |
| Eating and drinking | 2,132 | 2,395 | 3,529 | 9,575 | 10,626 | 13,003 |
| Food | 10,960 | 8,358 | 10,156 | 19,233 | 32,768 | 40,777 |
| Filling sta's. | 1,787 | 1,968 | 2,822 | 3,284 | 7,533 | 10,536 |
| General merchandise | 9,015 | 5,730 | 6,475 | 11,802 | 17,235 | 19,006 |
| Other | 3,024 | 2,130 | 2,526 | 7,270 | 9,093 | 12,002 |
| Total | 32,849 | 24,470 | 30,730 | 62,008 | 90,754 | 110,370 |
| All retail | 48,459 | 32,791 | 42,042 | 78,034 | 143,689 | 170,741 |

**Securities Trading.** Trading in securities underwent a mushroom growth during the first three decades of the twentieth century. The New York stock exchange had been organized informally in 1792 and formally in 1817, primarily to facilitate trading in Federal government securities. Exchanges were subsequently organized in several of the large commercial cities, but the bulk of the trading was always done in the New York stock exchange. As time went on, the stocks of the United States Banks and of state-sponsored internal improvements, railroad securities, and finally other industrial securities were listed for trading. Throughout the nineteenth century most of the trading was in government and railroad bonds. The volume of sales of all types of securities, for that matter, was diminutive compared with that in more recent times. After the depression of the 1890's was over, however, a wave of corporate consolidations generated a veritable flood of industrial bonds and stocks. Activity in these securities during the next fifteen years completely overshadowed the trading in Federal government bonds and, except for a brief flurry in 1905, in state and municipal issues. The securities market was very sensitive to changes in economic conditions and came to be widely reguarded as a business barometer.

*Stock Market Boom.* The boom years of the middle 1920's were characterized by rapid growth of stock trading. The number of shares sold on the exchange climbed from 236,000,000 in 1923 to 454,000,000 in 1925 and 920,000,000 in 1928, with prices continuously rising. These figures, expressed in terms of shares, exaggerate to some extent the

increase in volume of sales because many corporations "split" their stock, some of them several times over, in order to keep the trading units down to a size convenient for the thousands of small amateur traders then in the market. Industrial bond volume was substantial, but did not grow after 1924. Trading in government bonds persistently declined, but that in foreign bonds just as persistently increased. Among industrial securities the most active were those of public-utility holding companies, which were rapidly expanding and extending their control to embrace operating utilities throughout the country. The record stock volume of 1,125,000,000 shares in 1929 came mostly after the price break in the autumn, 16,400,000 shares being traded on the single memorable day of October 29, after which the exchange was forced to close temporarily.

*Obstacles to Recovery.* The securities market did not materially participate in the revival of the mid-1930's for several reasons. Perhaps most important was the newly imposed Securities Exchange Act restriction on short selling, margin trading, and other practices. Furthermore, new corporate securities were not forthcoming, partly, it was alleged, because of complex and expensive registration and other requirements in the Securities Act, although at least equally important were doubts on the part of potential issuers that new capital could be profitably employed. Finally, the great majority of speculative traders who had participated in the boom of the 1920's simply had neither the courage nor the money to re-enter the market. Deficit financing and long-term borrowing by the Federal government brought on substantial trading in its bonds, particularly in 1934, but foreign bonds were anathema. A flurry of activity occurred in industrial bonds and stocks during the abortive prosperity of 1936 and the minor recession which followed in 1937.

The war's conclusion brought some resurgence of activity in industrial securities. A number of factors, however, acted to prevent the development of a boom. During the war the capital needs of many munitions-producing enterprises had been met, in part at least, by direct government loans. Their capital requirements for postwar reconversion could not be met from this source, but the prevailing low interest rates made it propitious for them to continue borrowing. Much of their borrowing consisted of direct loans from large institutional investors, such as insurance companies, so that the supply of bonds in the open market was not greatly augmented. Stock trading increased somewhat; but commodity price controls, materials shortages, and wartime tax rates and the emergence of numerous labor disputes tended to counteract any bright prospects for corporate earnings. This picture began to change in 1952. Corporate earnings and dividends were at their highest levels, and attitudes of investors changed to one of enthusiam. By 1955 stock prices were at an all-time high. The volume of stock sales on the New York stock exchange for the first four months of 1955 was 255,000,000 shares.

SALES ON THE NEW YORK STOCK EXCHANGE, 1910 TO 1953

| YEAR | STOCK SALES (*million shares*) | BOND SALES (*dollar par value in millions*) | | |
|---|---|---|---|---|
| | | *Corporate* | *United States Government* | *State, Mun., and For. Government* |
| 1910 | 164 | 592 | less than .5 | 43 |
| 1915 | 173 | 907 | 3 | 51 |
| 1920 | 227 | 827 | 2,861 | 288 |
| 1925 | 454 | 2,332 | 391 | 661 |
| 1929 | 1,125 | 2,182 | 142 | 658 |
| 1930 | 810 | 1,927 | 116 | 721 |
| 1932 | 425 | 1,531 | 504 | 676 |
| 1933 | 655 | 2,099 | 501 | 769 |
| 1934 | 324 | 2,239 | 885 | 602 |
| 1936 | 496 | 2,899 | 319 | 359 |
| 1938 | 297 | 1,484 | 127 | 249 |
| 1940 | 208 | 1,414 | 39 | 216 |
| 1942 | 126 | 2,181 | 7 | 124 |
| 1943 | 279 | 3,130 | 4 | 120 |
| 1945 | 378 | 2,148 | 8 | 106 |
| 1946 | 364 | 1,265 | 19 | 81 |
| 1947 | 254 | 970 | 3 | 102 |
| 1948 | 295 | 910 | 1 | 86 |
| 1949 | 271 | 723 | .. | 93 |
| 1950 | 525 | 1,008 | 2 | 103 |
| 1951 | 444 | 730 | 2 | 92 |
| 1952 | 338 | 693 | .. | 80 |
| 1953 | 355 | 683 | .. | 93 |

**Role of Foreign Trade.** It is sometimes said that no leading commercial nation is less dependent on foreign trade than the United States. By this is meant, apparently, that the volume of its foreign commerce, while larger than that of any other country, is insignificant compared with that of its domestic trade. Throughout its history, to be sure, the total quantity of its exports and imports has never been more than 10 per cent of its production of goods entering into trade. Compared with domestic trade in the sense of money payments, indeed, the value of its foreign trade is almost infinitesimal. Such comparisons, however, obscure the fact that foreign commerce in certain commodities, with certain areas, and at certain times may have an importance entirely out of proportion to its size. Some commodities which are producible, if at all, only at an excessive cost disadvantage, are essential industrial raw materials, even though in small amounts. Other commodities are produced and distributed domestically under such conditions that sales abroad, though small, may at times be the margin of difference between success and failure for the producer.

**Development of Foreign Trade.** One of the first steps taken by the Federal government in 1792 was passage of legislation to promote overseas commerce by allowing lowered duties on imports carried in American vessels. During the last decade of the eighteenth century about half of the exports, which consisted almost entirely of crude foodstuffs and other raw materials, went to the British Isles and Dominions. Nearly three fourths of the imports, consisting of manufactures and other supplies not produced in this country, came from those sources. Great Britain had closed the West Indies to American traders, but when she became involved in war with France in 1793 the distraction prevented her from keeping the embargo effective. Although the United States remained neutral during the Napoleonic Wars, our ships supplied nations on both sides of the conflict. A considerable portion of the supplies originated in the West Indies and were re-exported from United States ports. During the years 1805-1808 these re-exports actually exceeded in value the exports of domestically produced commodities. Domestic exports also increased, however, because war and crop failures in the European nations made them heavily dependent on American agriculture. France and Great Britain each resented the material support which the United States gave the other. Each issued orders forbidding this country to trade with the other. France lacked the ships to enforce her orders, but the British effectively harassed our commerce, even with other neutrals. The resulting War of 1812 reduced United States foreign trade to a mere trickle. Since a high proportion of the country's population was engaged in agriculture and another large segment directly

or indirectly in shipping and shipbuilding, the serious effects of this blow were widespread. The war, however, had the additional effect, which in the long run proved favorable, of asserting American commercial independence and of stimulating domestic manufacture.

*Rise of the Tariff Issue.* Immediately after the close of the war foreign trade rose to a new record level. But within a few years the British Corn Laws restricted United States exports of grain, her own tariffs on textile products and some metals reduced her imports of these important commodities, and in the depression which followed the crisis of 1819 foreign trade again dwindled. The tariff laws of 1824 and 1828, particularly the latter, which earned the popular epithet "Tariff of Abominations," extended the protective principle so far that it created between the leading political parties a major issue which continued for more than a century. Under the law of 1832 the average rate on dutiable commodities was 33 per cent ad valorem. In 1833 provision was made for gradual reduction to a uniform rate of 20 per cent by 1842, but in the latter year high duties were reenacted. In 1846 the British Corn Laws were repealed and the United States tariff law effected some moderation of rates. The law of 1857 brought further reductions, the rate on most dutiable commodities being made 24 per cent ad valorem. In spite of protective tariff legislation and of setbacks in the depressions of 1837, 1842, and 1857, foreign trade grew nearly fivefold between 1820 and 1860. The natural resources of the United States and its specialization in agriculture gave it an advantage over nearly all the rest of the world in production of such staples as cotton and grains. Europe, on the other hand, was reaping the fruits of the Industrial Revolution and was able to supply this country with urgently needed manufactures, many of them produced from raw materials of American origin. Foreign commerce, furthermore, was stimulated by improvements in the art of shipbuilding, such as the development of the clipper ship by American shipbuilders and of the iron steamship by the British. With few exceptions the balance of trade continued to be adverse to the United States. That is, its commodity imports exceeded its commodity exports in value, the difference being settled by foreign investment of capital in such American internal improvements as canals and railroads, by American shipping service rendered to foreigners, and after 1850 by exports of gold from the newly discovered deposits in the West.

*Position in 1860.* In 1860 three fourths of the United States' exports went to Europe and more than half of the rest to its neighbors on the North American continent, including the West Indies. Seven tenths of the exports consisted of crude foodstuffs and materials for manufacture, the largest single item being cotton destined for British mills. Other leading items were grains, flour, meat, and tobacco. America's best customers, apart from Great Britain, were France, Germany, Holland, and Spain. Of American imports three fifths came from Europe, the largest items being woolen and cotton textiles from British mills. Half of the remainder consisted of foodstuffs, such as West Indian sugar, from North American countries. No large volume of trade had yet developed with South America, the Orient, or Africa, although Brazilian coffee was becoming an item of some importance, and the China trade, while small, provided an outlet for certain American manufactures unmarketable in Europe and a source of exotic items not available either in Europe or the Western Hemisphere.

During the Civil War import duties were greatly increased, partly to raise revenue and partly to compensate for the impact of greatly increased domestic excise taxes. Although some trade with European and other nations moved in and out of northern ports during the war, the blockade of southern ports practically cut off exports of the leading 1860 item, cotton, and greatly diminished those of tobacco. The South had thought England so dependent on cotton that if her supply were cut off she would be forced to intervene on behalf of her supplier. The British mills, however, were able to continue operating on the stocks they had accumulated during the bumper crop years of the late fifties, and their government gave no substantial aid to the secessionists.

*The High-Tariff Era.* After the close of the war most of the domestic excises were removed, but northern manufacturers were able to prevent reduction of the high import duties, from whose protection they had profited. The agricultural South, of course, was injured by protective tariffs, but it was unable effectively to counteract the Northern pressure on Congress. Development of the West, as a result of the Homestead Act and of transcontinental railroad construction, opened up new grain- and cattle-producing regions, new mines and petroleum deposits, all of which contributed to the growth of exports. They were principally useful to industrial Europe. Import trade grew much more slowly, being inhibited by protective tariffs, and in the middle 1870's its value was overtaken by that of exports. From this time forward the trade balance, with few exceptions, remained favorable. For some years the excess of commodity exports over commodity imports continued to be so small that it was entirely absorbed by "invisible items" such as interest on earlier foreign capital investments in American internal improvements, expenditures of American travelers abroad, and payments to foreigners for shipping and marine insurance service. Freight payments to foreign shipowners were appreciable because a large proportion of American vessels had been destroyed, sold to foreigners, or converted to military use during the Civil War, and the deficiency was

FOREIGN TRADE OF THE UNITED STATES, 1800 TO 1953
(*Millions of dollars*)

| *Year* | *Exports* | *Imports* | *Total* | *Trade Balance*[1] |
|---|---|---|---|---|
| 1800 | 71 | 91 | 162 | —20 |
| 1810 | 67 | 85 | 152 | —18 |
| 1820 | 70 | 74 | 144 | — 4 |
| 1830 | 72 | 63 | 135 | 9 |
| 1840 | 124 | 98 | 222 | 26 |
| 1850 | 144 | 174 | 318 | —30 |
| 1860 | 334 | 354 | 688 | —20 |
| 1865 | 166 | 239 | 405 | —73 |
| 1870 | 393 | 436 | 829 | —43 |
| 1875 | 513 | 533 | 1,046 | —20 |
| 1880 | 836 | 668 | 1,504 | 168 |
| 1885 | 742 | 578 | 1,320 | 164 |
| 1890 | 858 | 789 | 1,647 | 69 |
| 1895 | 808 | 732 | 1,540 | 76 |
| 1900 | 1,394 | 850 | 2,244 | 544 |
| 1905 | 1,519 | 1,117 | 2,636 | 401 |
| 1910 | 1,745 | 1,557 | 3,302 | 188 |
| 1915 | 2,769 | 1,674 | 4,443 | 1,094 |
| 1920 | 8,228 | 5,278 | 13,506 | 2,950 |
| 1925 | 4,910 | 4,227 | 9,136 | 683 |
| 1930 | 3,843 | 3,061 | 6,904 | 782 |
| 1935 | 2,283 | 2,047 | 4,330 | 235 |
| 1940 | 4,021 | 2,625 | 6,647 | 1,396 |
| 1945 | 9,806 | 4,136 | 13,942 | 5,670 |
| 1950 | 14,396 | 12,053 | 26,449 | 2,343 |
| 1953 | 21,337 | 16,628 | 37,965 | 4,709 |

[1] Favorable unless marked negative (—). Does not include unilateral transfers.

not afterward made up by new construction. American shipbuilders found that they could not effectively compete with British builders, and so turned their energies and capital to other industries. Throughout the 1880's the high-tariff opponents, particularly in the West and South, sought tirelessly to secure reductions. Apart from extension of the free list to include several commodities which did not compete with American production in any event, their efforts were largely fruitless. By this time the high-tariff advocates had been forced to abandon the attitude of "protection of infant industries" as a basis for their position, because the protected industries were no longer infant. Instead, they argued that tariffs "protect the American worker from pauperization by competition with cheap foreign labor." This shifting of ground gave protectionism an appeal to the masses rather than merely to industrialists and provided apparent justification for high tariffs as a permanent commercial policy and not just as a temporary expedient.

The McKinley Act of 1890, titled "an act to reduce the revenue and equalize duties on imports," did not merely provide for retention of the protection established by the high Civil War duties; it greatly extended the protective system and raised the average level of duties to nearly 50 per cent. It placed sugar, coffee, tea, and hides, none of which offered serious competition to American producers, on the free list, but authorized the President to impose import duties on them if he considered that the countries of origin were levying "unjust or unreasonable" duties on United States exports. Under this threat, reciprocal trade agreements were made with Brazil, with several Central American countries, and with Great Britain and Spain for their West Indian colonies. This tariff act, as well as the silver legislation enacted in the same year, undoubtedly contributed to the price rise which culminated in the crisis of 1893 and to the decline of foreign as well as domestic trade in the following depression. The Congress which had been elected in 1892 was less protectionist than its predecessor, and in 1894 it passed the Wilson Act, providing some slight moderation of import duties. The following Congress, however, was strongly protectionist, and the Dingley Act of 1897 raised the rates to a record 57 per cent level.

*Development of New Markets.* As indicated by the accompanying table, European nations in 1900 continued to be the United States' best customers, still taking about three fourths of United States exports, and North American countries still took slightly more than half of the rest. However, South America, Asia, and Oceania were beginning to be significant export areas, each of them taking more than all of them together had taken in 1860. By the turn of the century an important shift was taking place in the commodity character of United States exports. Manufactures, which in 1860 constituted less than one third of the total, now amounted to three fifths in 1900. Raw cotton for British mills again was the principal single item, with animal products and grains and their preparations following in that order. But petroleum and its products, machinery, and metals and their products, none of which had been important items in 1860, had begun to assume some significance. The imports picture was even more sharply changed. That Europe supplied only slightly more than half the total in 1900 reflected the decline of the United States' dependence on European manufactures. Although its North American neighbors provided only one third of the rest, sugar was by far the largest single item. South America made appreciable contributions of Brazilian coffee and Argentine hides for the rapidly growing boot and shoe industry. The most significant increase was in imports from Asia. These consisted mostly of raw silk from Japan and crude rubber and tin from the Malay States and East Indies. The profound change in the commodity character of imports may be summarized by the statement that materials for the supply of American industries, which in 1860 had constituted only one third of the total, amounted to three fifths in 1900.

Regional Distribution of United States Foreign Trade, 1860 to 1953
(*Millions of dollars*)

| *Region* | *1860* | *1900* | *1940* | *1945* | *1953* |
|---|---|---|---|---|---|
| Exports to: | | | | | |
| North America (north) | 23 | 187 | 725 | 1,216 | 2,995 |
| North America (south) | 29 | | 341 | 726 | 1,575 |
| South America | 16 | 39 | 436 | 646 | 1,519 |
| Europe | 249 | 1,040 | 1,645 | 5,492 | 2,868 |
| Asia | 8 | 65 | 619 | 845 | 1,996 |
| Oceania | 5 | 43 | 94 | 524 | 173 |
| Africa | 3 | 19 | 161 | 357 | 503 |
| Total | 333 | 1,393 | 4,021 | 9,806 | 15,747 |
| Imports from: | | | | | |
| North America (north) | 24 | 129 | 437 | 1,153 | 2,462 |
| North America (south) | 44 | | 256 | 752 | 1,278 |
| South America | 35 | 94 | 395 | 962 | 2,377 |
| Europe | 217 | 441 | 390 | 397 | 2,334 |
| Asia | 29 | 140 | 981 | 407 | 1,624 |
| Oceania | 1 | 35 | 35 | 296 | 202 |
| Africa | 4 | 11 | 131 | 169 | 594 |
| Total | 354 | 850 | 2,625 | 4,136 | 10,873 |

*American Ascendancy in World Trade.* Paralleling in importance these shifts in the character of exports and imports was the contrast in their relative values. In 1860 the foreign trade was in approximate balance. In 1900 the total value of commodity exports exceeded that of commodity imports by 64 per cent. This large favorable balance of trade heralded an important change in the country's position in international affairs. In the twentieth century the foreign trade of the United States expanded more than six times as much as in all its previous history and made it the leading commercial nation of the world. This growth resulted from many factors, of which the role played by the United States in World Wars I and II was predominant. Only slightly less important, and closely related thereto, was the increasing tempo of the nation's industrial development. The first decade was characterized not only by an expansion of exports, but also by an increase in the shift, previously mentioned, from crude agricultural and mineral products to finished and semifinished manufactures. Possessing an abundance of the basic natural resources requisite to industrialization, an adequate inland transportation system, plentiful labor of high quality, and ingenuity which developed mechanical mass-production techniques, the nation began to compete with European manufactures on their own ground. High tariffs inhibited importation of the latter, but industry brought in ever-increasing quantities of needed materials like rubber, silk, tin, nickel, and hides, which were domestically unavailable or available in inadequate amounts. The rising and widely distributed national income, furthermore, provided purchasing power to make effective an increasing popular demand for tropical foodstuffs.

The Payne-Aldrich Tariff Act of 1909 raised almost as many duties as it lowered. It kept the protection system virtually unchanged. An antiprotectionist Congress in 1913, however, passed the Underwood Act which, while not a free-trade measure, brought the most thorough revision of tariff policy since the Civil War and reduced the average level of rates to about 30 per cent.

*World War I.* Before the lower rates had been in effect long enough for their consequences to become apparent, war broke out in Europe, drastically altering the character of American commerce. Imports from the belligerents were greatly reduced as they devoted their resources and manpower to military uses. On the other hand, exports to them, not only of munitions but also of food and other consumption goods, greatly increased. The trade balance became more favorable, and American indebtedness abroad was almost entirely wiped out. After the United States entered the war its foreign trade was restricted by the needs of its own expeditionary forces and by the increased sinking of its ships. A program was instituted for construction of a merchant marine under government sponsorship and financing, however, so that the foreign trade was by no means completely cut off. After the war, shipments for the relief and rehabilitation of war-torn nations took the place of munitions. A considerable portion of the exports, which reached their peak in 1920, was financed by long-term loans, so that the United States, which had been a debtor nation up to World War I, became a creditor of great magnitude.

COMPOSITION OF UNITED STATES EXPORTS, 1860 TO 1953
(*Millions of dollars*)

| *Classification* | *1860* | *1900* | *1940* | *1945* | *1953* |
|---|---|---|---|---|---|
| COMMODITY CLASSES: | | | | | |
| Crude materials | 216 | 325 | 456 | 875 | 1,624 |
| Crude foodstuffs | 12 | 226 | 74 | 432 | 962 |
| Manufactured foodstuffs | 39 | 320 | 166 | 1,246 | 706 |
| Semimanufactures | 13 | 153 | 908 | 782 | 1,423 |
| Finished manufactures | 36 | 347 | 2,330 | 6,254 | 10,909 |
| Total | 316 | 1,371 | 3,934 | 9,589 | 15,625 |
| PRINCIPAL ITEMS: | | | | | |
| Cotton, unmanufactured | 192 | 243 | 213 | 279 | 521 |
| Grains and preparations | 20 | 159 | 34 | 386 | 589 |
| Tobacco, unmanufactured | 16 | 29 | 44 | 239 | 339 |
| Meat products | 14 | 176 | 36 | 290 | 60 |
| Cotton manufactures | 11 | 24 | 76 | 223 | 329 |
| Copper and products | 2 | 59 | 110 | 52 | 116 |
| Iron, steel and products | ... | 39 | 516 | 584 | 494 |
| Petroleum and products | ... | 84 | 310 | 666 | 691 |
| Machinery | ... | 78 | 671 | 1,188 | 3,000 |
| Autos, parts, accessories | ... | ... | 254 | 543 | 1,416 |

**World Trade Decline.** The crisis of 1920 brought an end to expansion. In spite of rapid recovery and prosperity in domestic trade, foreign trade declined throughout the twenties. Booming prices attracted to the domestic market nearly all the attention of American manufacturers and merchants, many of whom had been interested in foreign markets only as dumping grounds for their surpluses. Imports were inhibited by the high duties of the Fordney-McCumber Act of 1922, which extended the protective system even to agricultural products and raised the general level of rates to about 36 per cent. America's World War I merchant marine had fallen into decay and, as after the Civil War, its obsolete ships were not replaced because American shipbuilders and operators found they could not economically compete with the British. The world-wide depression which began in 1929 brought a further decline in foreign trade. Reduction of purchasing power abroad severely hit our exports, not only of manufactures but also of foodstuffs and even of cotton. Organized pressure from agriculture, later joined by manufacturing interests, led Congress in 1930 to pass the Hawley-Smoot Act, which raised the rates to an average of nearly 53 per cent and further restricted imports. This act, coming as it did when trade was already in the doldrums, aroused resentment both abroad and at home. Other countries raised their tariff and quota barriers against American exports. Even Great Britain, which for generations had been ardent in its advocacy of free trade, enacted protective tariff legislation. Domestically the Hawley-Smoot Act became an important issue in the 1932 election campaign. The new Congress did not revise the tariff, but in 1934 it passed a Trade Agreements Act which authorized the President at his discretion to enter into agreements for reduction of duties on particular commodities coming from particular countries in exchange for trade concessions from those countries. Under this authority during the following decade reciprocal trade agreements were signed with twenty-seven countries, including the United Kingdom and the British colonies, Canada, France and its colonies, the Union of Socialist Soviet Republics, the Kingdom of the Netherlands, Cuba, Brazil, and most of the other Latin-American countries.

**Effects of World War II.** Foreign trade revived somewhat during the later 1930's, partly due to war preparations abroad. Its growth, however, was restrained by the Johnson Act of 1934, forbidding loans to governments in default on debts to the United States (which included most of the country's allies in World War I and its best customers), by the 1936 embargo on loans to all belligerents, and by the Neutrality Acts of 1937 and 1939, forbidding American vessels to trade with belligerents.

*Trade Position in 1940.* Total exports in 1940 were nearly three times those in 1900. Only 41 per cent of the 1940 exports went to Europe, however, scarcely more than half the 1900 proportion. North American countries received 27 per cent, nearly twice the proportion in the earlier year. Asiatic countries received 15 per cent and South American countries 11 per cent. The commodity distribution of exports clearly depicted the nation's complete industrialization, seven eighths of the total consisting of manufactures. Raw cotton was no longer the principal item. Machinery, iron and steel and their products, petroleum and its products, automobiles and parts, in that order, had risen to the leadership. The exports picture, of course, was colored in no small degree by the outbreak of World War II in Europe. A considerable proportion of all the leading items mentioned above consisted of equipment and supplies destined for direct or indirect military use by Great Britain, France and Canada.

The change which took place since 1900 in the imports situation was hardly less drastic. European nations, which in the former year had supplied 52 per cent, now supplied only 15 per cent of the total. The Asiatic area provided 37 per cent as contrasted with 17 per cent, and North American countries 26 per cent as contrasted with 15 per cent at the turn of the century. Even South America's share was increased from 11 to 15 per cent. All these increases in proportions represented even greater absolute increases, for the value of 1940 total imports was more than three times that of 1900. Nearly 73 per cent of the 1940 imports consisted of supplies, crude and semimanufactured, for American industry as compared with 60 per cent in 1900. The largest single item was Malayan and East Indian rubber for use by the automotive industry. Nonferrous metals and ores, especially tin from Malaya and nickel from Canada, were second, with wood pulp and paper, principally from Canada, a close third. These were followed by Brazilian coffee, Japanese silk, and Cuban sugar in that order. A new entry to the list of principal items was petroleum and its products, which also appeared on the list of leading exports. The imports consisted mainly of crude petroleum shipped in by

American refiners from Venezuela and exported as refined petroleum products to various areas.

COMPOSITION OF UNITED STATES IMPORTS, 1860 TO 1953
(*Millions of dollars*)

| *Classification* | *1860* | *1900* | *1940* | *1945* | *1953* |
|---|---|---|---|---|---|
| COMMODITY CLASSES: | | | | | |
| Crude materials | 40 | 276 | 1,011 | 1,164 | 2,603 |
| Crude foodstuffs | 46 | 98 | 285 | 693 | 2,184 |
| Manufactured foodstuffs | 60 | 133 | 277 | 462 | 1,108 |
| Semimanufactures | 35 | 134 | 559 | 928 | 2,687 |
| Finished manufactures | 172 | 209 | 409 | 828 | 2,195 |
| Total | 353 | 850 | 2,541 | 4,075 | 10,777 |
| PRINCIPAL ITEMS: | | | | | |
| Wool manufactures | 43 | 16 | 25 | 19 | 140 |
| Cotton manufactures | 33 | 42 | 31 | 34 | 80 |
| Sugar | 31 | 100 | 113 | 202 | 426 |
| Coffee | 22 | 52 | 127 | 346 | 1,468 |
| Hides and skins | 11 | 58 | 50 | 48 | 74 |
| Wool, raw | 5 | 20 | 85 | 250 | 295 |
| Nonferrous ores and metals | 3 | 35 | 204 | 213 | 703 |
| Furs | 2 | 12 | 80 | 172 | 73 |
| Silk, raw | 1 | 45 | 125 | 1 | 26 |
| Rubber, crude | 1 | 31 | 318 | 78 | 331 |
| Wood pulp, paper, and products | 1 | 5 | 193 | 315 | 895 |
| Petroleum and products | ... | ... | 70 | 157 | 762 |

The excess of exports to Great Britain over imports from that country was responsible in large part for the 1940 favorable balance of trade. Since her industry had been converted to war production, she was unable to maintain her normal peacetime exports. Under the Johnson Act she was not eligible to receive long-term credits in this country. In desperation, she liquidated practically all of her remaining American investments in order to pay cash for her purchases, and carefully restricted such purchases to minimum amounts of absolute essentials for prosecution of the war.

*Lend-Lease Shipments.* At this juncture Congress passed the Lend-Lease Act authorizing shipment on government account to nations opposing the Axis powers, not only munitions but also industrial materials and equipment, food,

LEND-LEASE AID, MARCH 11, 1941, TO JULY 1, 1945

| | *Thousands of dollars* | *Percent of total* |
|---|---|---|
| Munitions | $20,691,562 | 49.2 |
| Petroleum products | 2,184,730 | 5.2 |
| Machinery | 2,180,020 | 5.2 |
| Metals | 2,069,780 | 4.9 |
| Miscellaneous industrial materials and manufactures | 4,407,914 | 10.5 |
| Food | 5,094,724 | 12.1 |
| Other agricultural products | 811,742 | 2.0 |
| Shipping and other services | 4,580,307 | 10.9 |
| Total | $42,020,779 | 100.0 |

or any other supplies which the President deemed essential for effective prosecution of the war, without definite arrangement as to repayment of the resulting credits. Throughout the rest of the war years most of the country's exports were under Lend-Lease.

Of the total, the United Kingdom received 43 per cent, the Union of Soviet Socialist Republics, 29 per cent; countries in the Middle East and Mediterranean areas, 11 per cent; China and India, 7 per cent; and Australia and New Zealand, 4 per cent. The United States received reverse Lend-Lease aid in the amount of $5,600,364,000, consisting mainly of capital installations abroad, munitions, petroleum products, and shipping services in approximately equal amounts. Of the total, the United Kingdom supplied 68 per cent, Australia and New Zealand 17 per cent, and India 9 per cent. Except for small token settlements and recoveries of unused supplies, the excess of Lend-Lease aid given over that received was regarded as part of the war cost and not as a favorable trade balance to be liquidated by subsequent imports or by capital investments abroad. Throughout the war the United States carried on considerable trade, both export and import, with Canada in munitions and war supplies, and with the Latin-American republics in nonwar commodities, on a normal exchange basis. This trade was closely controlled by a licensing and quota system. Submarine sinkings of both British and American ships forced this country into a shipbuilding program which dwarfed that of World War I. Disposition of this merchant fleet, by far the largest of any nation, remained unsettled after the war. The foreign trade pattern in 1945, of course, was strongly influenced by exports of war supplies during the first half and of relief supplies during the last half. Of the total exports, 56 per cent went to Europe, 20 per cent to North American countries, 14 per cent to the Pacific war theater, and 7 per cent to South America. Nearly seven eighths consisted of finished and semifinished manufactures, of which machinery, petroleum products, iron and steel products, and automotive equipment were the leading items in that order. Of the total imports, 46 per cent came from North American countries, 23 per cent from South America, 17 per cent from the Pacific area, and 10 per cent from Europe. Less than one third consisted of finished manufactures, the leading items being coffee, wood pulp and paper, wool, nonferrous ores and metals, and sugar, in that order. The volume of foreign trade expanded sharply with the postwar prosperity, as is shown by the export and import statistics for 1953. In that year imports were more than double the 1945 level, and exports had increased over 60 per cent; however, the commodity classes had shown little change.

## OTHER TRADE FACTORS AND TRENDS

**Production, Employment, and Payrolls.** In some ways the situation and trend of general business conditions at any particular time may be revealed less completely by prices and trade volume than by certain other factors. Among these other measures, three of which are highly regarded by business analysts, are production, employment, and payrolls. Production is both fundamental, since it measures the quantity of physical goods made available for trading, and sensitive, since it tends to fluctuate more widely than does total business activity. The significance of employment, of course, is in its indication of the working population's occupation in income-producing activity. Payrolls help fill out the employment-income picture by including the effects of wage-rate changes and of part-time employment.

In the 1921 recession production and employment were curtailed only a little more than 20 per cent. Payrolls were reduced about 35 per cent, however, because many factories effected a portion of the production adjustment by putting retained workers on part-time. During the generally prosperous eight years which followed, the output of physical goods doubled. Employment increased by only a little more than one-fourth, reflecting not only a return to full-time employment but also a rise in workers' productivity; the latter was consequent upon greater mechanization of production

processes and thus improved efficiency in utilization of labor, for which the workers were compensated by a more than proportionate increase in payrolls. An important aspect of production during this period was that the largest increases were in durable goods such as automobiles, home furnishings, and industrial equipment. When depression struck in 1929-1932, the demand for these goods collapsed, since they did not require immediate replacement. Their production was rapidly curtailed, and the depression soon spread to nondurable goods. The number of workers in all factory employment declined about 40 per cent. Output of physical goods dropped back nearly 50 per cent to the 1921 level as workers again went on part-time. For this reason and because of wage-rate reductions, factory payrolls fell off almost 60 per cent to a level far below that of 1921.

In the 1933-1937 recovery period productivity was restored as employment and production returned to the 1929 figures. Payrolls rose a little more sharply, but did not go as high as in 1929. All three indexes descended together in the minor setback of 1937-1938, and they rebounded together under the impetus of the 1939-1940 national defense program. During the 1941-1943 period of all-out war production, industrial effort and output rose to unprecedented heights, although the change in character of product casts some doubt on the comparability of the index figures with those of earlier peacetime years.

Immediately after the European invasion in mid-1944 the military branches of the government began cutting back their orders for munitions and stepping up the rate at which they drafted men into the armed services. As a result, factory production and employment fell off slightly. In order to expedite the flow of workers from plants whose munitions orders had been reduced to plants with continuing programs, however, the latter were permitted to raise their wage rates, and payrolls as a whole increased a little. Even before V-E Day and V-J Day, military production programs were being cut back drastically, but reconversion to peacetime production was slow. During 1945 and 1946 factory output fell off nearly one third, and employment and payrolls about one fifth, from the 1943 peak. After the 1946 reconversion period, production, employment, and payrolls began to rise rapidly, and soon surpassed the wartime levels. In comparison to the 1947-1949 averages, up to then the highest in the country's history, production in 1954 was 25 per cent higher, employment 10 per cent higher, and payrolls were 38 per cent higher. *See also* BANK FUNCTIONS AND OPERATIONS; BANKING, HISTORY OF; BANKING, INVESTMENT; BANK LAWS AND SUPERVISION; CREDIT INSTRUMENTS; FOREIGN EXCHANGE AND CREDIT; INDUSTRIAL AND MARKET CENTERS; MARKETING AND MERCHANDISING; MONEY. R. W. Ma. and J. W. L.

**TRADE-MARK.** The Federal Trade-Mark Act of July 5, 1946, which became effective on July 5, 1947, defined trade-marks as including: "any word, name, symbol, or device or any combination thereof, adopted and used by a manufacturer or merchant to identify his goods and distinguish them from those manufactured or sold by others" (Section 45).

**Historical Aspects.** The statutory definition is a restatement of common-law concepts of the meaning and function of trade-marks, which have been used since antiquity to identify the origin of merchandise, the processors and sellers of commodities, and the makers of articles of commerce. Indeed, the use of identifying trade-marks was at times made compulsory by law in various jurisdictions and localities centuries ago, and trade-mark regulation was associated with the earliest attempts at economic regulation in the interest of consumer protection and maintenance of standards of quality by the English guilds. Not only has the importance of the trade-mark kept pace with the growth of manufacture, trade, and commerce, but the trade-mark has been a vital factor in the facilitation of business growth. The law's concern with the protection of trade-mark rights was well phrased by the United States Supreme Court opinion in Mishawaka Mfg. Co. v. Kresge Co., 316 U. S. 203,205 (1941): "The protection of trade-marks is the law's recognition of the psychological function of symbols. If it is true that we live by symbols, it is no less true that we purchase goods by them. A trade-mark is a merchandising short-cut which induces a purchaser to select what he wants, or what he has been led to believe he wants."

**Modern Federal Law.** Nevertheless, only belatedly has Federal law assumed its share of responsibility for trade-mark protection and supplied much-needed systematization for the regulation of a business adjunct which has outgrown localism. Trade-mark legislation was first enacted by Congress in 1870. This original statute provided for registration of trade-marks in the Patent Office and made the wrongful use of the registered trade-mark by unauthorized persons a cause of action for damages in a civil suit by the owner of the registered mark. The fraudulent use of registered trade-marks was first made a criminal offense by Congress in 1876. Prosecutions brought under these criminal provisions culminated in the Trade-Mark Cases decision by the United States Supreme Court in 1879, which invalidated the trade-mark law on the ground that the legislation was not confined to trade-marks used in commerce, which was subject to regulation by the Federal Government, and hence exceeded congressional powers under the Constitution.

In 1881 Congress enacted trade-mark legislation which eliminated the invalidating defects noted by the Supreme Court in the earlier statutes, but which was woefully inadequate, in that application of the law was restricted to trade-marks used in foreign commerce and with Indian tribes and excluded interestate commerce from Federal protection. Not until 1905 did new basic legislation accord to trade-marks used in interstate commerce the comprehensive protection needed by the development of regional and national commerce, with its concomitant enhancement of the importance of the trade-mark as a species of business good will. The Act of 1905, and the laws amendatory thereof, were supplemented by the Federal Act of 1920. These laws, as well as incidental trade-mark provisions in other laws dealing primarily with unrelated subjects, were co-ordinated and codified into a single enactment by the Federal Act of 1946.

With reference to Federal statutes prior to that of the Act of 1946, it was generally held that Federal registration of trade-marks conferred no substantive rights upon the registrant. The courts declared that registration could not confer a title to a trade-mark, if some other person had acquired a prior right by adoption and use. Federal registration did, however, accord the registrant important advantages relating to procedure, proof, and redress in infringement suits. Registration under the Act of 1905 is held to create a presumption of validity, to constitute prima-facie evidence of ownership of the trade-mark by the registrant. Another important advantage is that the registrant can seek redress in the federal courts against infringement of trade-mark in interstate or foreign commerce without regard to the restrictions concerning diversity of citizenship and minimum amount in controversy, which otherwise prevail when Federal jurisdiction is invoked.

The Act of 1946 has extended the advantages and protection of Federal registration, and indeed appears to constitute a new departure in trade-mark law in that it purports to base substantive rights upon registration as distinguished from evidentiary advantages and mere implementation of common-law rights. Thus, Section 15 of the Act of 1946 declares that upon the expiration of five years following registration under the act, "principal register" trademarks shall be incontestible (except in certain instances specified in the law) and thereupon the certificate of registration shall be conclusive evidence (subject to statuatory exception) of the registrant's exclusive right to make appropriate use of the registered mark in interstate and foreign commerce (section 33[b]).

Any trade-mark used in interstate or foreign commerce by which the goods of the applicant may be distinguished from the goods of others is registrable on the "principal register" of trade-marks in the Patent Office, under the Act of 1946, except such as fall within a category of marks expressly made ineligible by the statute. Among the marks thus disqualified are those consisting of, or comprising, immoral, deceptive, or scandalous matter, flags or insignia of governmental entities, names or portraits of living persons used without due authorization, or the name or portrait of a deceased president of the United States during the lifetime of his widow except by her consent.

In addition, registration will be denied to a mark which so resembles a mark registered in the Patent Office, or a mark or trade-mark previously used by others, as to be likely, when applied to the goods of the applicant, to cause confusion or mistake or to deceive purchasers. However, the law provides for issuance of concurrent registrations to applicants, each limited to a designated area or mode of use, in cases when concurrent, lawful use of marks makes such type of registration an equitable solution of the relative rights of the parties. Marks which are merely descriptive of goods, or geographically descriptive of them, are not registrable unless the mark has become distinctive of the applicant's goods. The act authorizes the Patent Office to accept as prima-facie evidence that the mark has become distinctive five years exclusive and continuous use of such mark by the applicant, in interstate or foreign commerce. A mark which is primarily merely a surname is not registrable.

The Act of 1946 provides for the registration of "service marks," which are defined in the law as "used in the sale or advertising of services to identify the services of one person and distinguish them from the services of others, and includes without limitation, the marks, names, symbols, titles, designations, slogans, character names, and distinctive features of radio or other advertising used in commerce" (Section 45).

An application for registration must comply with the rules and regulations of the Patent Office and include a written application, a drawing of the mark, five specimens of facsimiles, and a filing fee of $25. The written application must be signed and sworn to by the applicant or an officer of a corporate applicant. It must contain a request for registration and, among other data, include the name, address, and citizenship of the applicant, and a declaration that the applicant is using the mark upon particularly described goods, in interstate or foreign commerce, and that to the best of the applicant's knowledge no one else has the right to use the mark in such commerce. The date of applicant's first use of the mark in connection with the goods specified in the application must be given, as well as the date of first use in interstate or foreign commerce. The Patent Office has established in its rules fifty-five classifications of goods and services, and the applicant should designate the class of his merchandise according to the official classification, as well as the manner in which the mark is used on, or in connection with, the particular goods described. The many detailed requirements of trade-mark registration render it essential that the applicant obtain a copy of the rules, if he is to prosecute his own application. However, the applicant may be represented by an attorney-at-law, or other person authorized to practice in trade-mark cases.

A certificate of registration remains in effect for twenty years, provided the applicant within one year next preceding the expiration of six years from the date of registration files an affidavit that he is still using the mark or showing special circumstances excusing nonusage. If the affidavit is not filed, the certificate of registration is cancelled at the end of the sixth year. Each registration may be renewed for a period of twenty years. A registered mark is assignable with the sale of the good will of a business and should be recorded.

All applications are treated as seeking registration on the principal register. The Patent Office under the Act of 1946, however, maintains a supplemental register, which is a continuation of the register under the Act of 1920. In this register are recorded trade-marks communicated to the Patent Office by the international bureaus provided for by the convention for the protection of trade-marks and commercial names made and signed in Buenos Aires on Aug. 20, 1910. In the supplemental register there may also be recorded descriptive trade-marks and certain other marks not eligible for registration in the principal register, if used for one year, or if domestic registration be required as a prerequisite to foreign registration. A mark registered on the supplemental register may be transferred to the principal register upon qualifying. Registration in the supplemental register is not prima-facie evidence of ownership, does not constitute constructive notice of the registrant's claims, and does not become incontestible.

The Act of 1946 contains a description of infringement of trademark in generic terms, including use in interstate or foreign commerce of a colorable imitation of any registered mark in connection with the sale of goods or services, likely to cause confusion, or mistake, or to deceive purchasers as to the source of origin of such goods or services. Redress for infringement of Federal Trade-Mark Registration includes provision for treble damages, as well as recovery of the profits of the infringer, and comprehensive injunctive relief.

The registrant of a mark is required to give notice of registration by displaying "Registered in the U. S. Patent Office," "Reg. U. S. Pat. Off.," or "R" enclosed with a circle. In the absence of such notice, recovery of damages or profits against an infringer may be had only upon a showing that he had actual knowledge of registration.

It must, moreover, be noted that the law of trade-mark infringement is merely a branch of the law of unfair competition. Courts of equity may enjoin as unfair competition the use of words associated with the business of others, even though such expressions are not eligible for registration as trade-marks and indeed not capable of becoming common-law trade-marks.

H. Si.

**TRADE UNIONS.** *See* Labor in the United States, History of; Labor Movement; Unions.

**TRADE WINDS.** *See* Meteorology.

**TRAFALGAR, BATTLE OF** [trəfæ'lgər], the greatest naval engagement of the Napoleonic Wars, off Cape Trafalgar, on the southwest coast of Spain, Oct. 21, 1805. Fought between a British fleet under Lord Nelson and a combined French and Spanish fleet under the French Admiral Villeneuve, the Battle of Trafalgar did not, as is sometimes asserted, save England from a French invasion. Napoleon had some weeks earlier withdrawn the army assembled along the English Channel and ordered it to march against Austria. Yet the completeness of the English victory ended once and for all any menace from French naval power. Nelson had 27 ships at his disposal, with which to oppose a slightly smaller allied fleet. His strategy called for a split of the enemy force in two and the subsequent piecemeal destruction of each half. This plan was carried out with such effectiveness that no less than sixty per cent of the allied fleet was captured. This success is all the more remarkable as the battle was fought near the protecting Spanish coast, which the allies sought to reach in vain; Nelson, whose brilliant strategy prevented their seemingly easy escape, was killed in the battle. M. K.

**TRAFFIC ACCIDENTS.** *See* SAFETY.

**TRAGEDY,** a term applied to a serious literary composition, usually a drama which ends unhappily. The original Greek word τραγῳδία (*tragedia*) comes from τραγῳδός, literally "goat-singer" (τράγος, he-goat; ᾠδός, singer), and this odd name for what was originally a choric ritual song and dance has provoked conflicting explanations: that the performance was attended by the sacrifice of a goat; that the prize for the best performance was a goat; or that the performers were originally dressed in skins as goatlike men or satyrs or creatures akin to satyrs.

At all events, from the fifth century B.C. onward τραγῳδία meant a serious drama, generally based on a heroic legend. It might end happily or unhappily, but it always involved scenes of pity or terror and had by this time acquired a dignity that contrasted with the burlesque of comedy or the satyr drama. This was also true of the Latin *tragoédia,* but the dark ages forgot that "tragedy" was necessarily drama at all. Thus in the fifth century of the Christian Era Dracontius of Carthage gave the name of tragedy to his *Orestes,* a narrative poem in hexameters; Isidore, two centuries later, calls Horace, Juvenal, and Persius "tragedians," and in Byzantine Greek the word, like the modern Greek τραγούδι, means simply "song." In medieval Western Europe the term came to be applied to any narrative with an unhappy ending: in Chaucer's words, "a ditee of a prosperitee for a tyme, that endeth in wrecchednesse." Accordingly Chaucer gives this name both to his own verse narrative, *Troilus and Criseyde,* and to the doleful anecdotes with which his Monk annoys the Pilgrims in *The Canterbury Tales.* Similarly Dante called the *Divina Commedia* a "comedy" simply because it ended in Paradise, and he remarks elsewhere that an unhappy tale was called a "tragedy" or "goat-song" because a goat is a noisome beast. His fourteenth-century commentator, Francesco da Buti, explained the term with still more ingenuity: any passage from good to evil fortune, he says, is like a he-goat, because the creature is superb with horns and beard in front, but naked and squalid behind. With the Renaissance men realized anew that tragedy was essentially drama, but the medieval stress on an unhappy ending has somehow persisted ever since.

Thus for Antiquity a tragedy was a serious play, not always with an unhappy ending; for the Middle Ages it became any narrative, provided that the end was unhappy; for the modern world it is again a play, but the unhappy ending has now become essential. In other words the strict modern counterpart of the ancient τραγῳδία is not so much "tragedy" as "serious drama." This point is of some importance. To ignore it distorts, for example, the sense of Aristotle's *Poetics* and obscures the continuity of European drama. For example, the *Iphigenia in Tauris* of Euripides is a τραγῳδία, but it is not a "tragedy"; it ends happily and is, for us, as much a "romantic drama" as *The Winter's Tale* or *The Tempest.*

### HISTORY

Aristotle says that tragedy developed from the dithyramb, a choric song and dance especially associated with Dionysus. An indication of this may be found as early as 600 B.C. in the case of Arion, famous for his legendary ride on the dolphin, who is said to have composed in the Dorian city of Corinth both dithyrambs and music of the tragic style (τραγικὸς τρόπος). Certainly the Dorians of the northern Peloponnesus claimed to have originated tragedy, and it is perhaps a relic of their influence that choric odes in Attic tragedy employ Doric dialect forms. Nevertheless, the true glory of having founded tragedy was generally assigned in antiquity to Thespis of Icaria, who flourished about the middle of the sixth century B.C.

The district of Icaria at the foot of Mount Pentelicus, twelve miles northeast of Athens, was an ancient center of Dionysiac worship, and even today the village is called Dionysos. Legend has it that Icarius of Icaria was chosen by the god to spread the blessings of wine among men, but he was murdered by some shepherds who imagined, when the wine went to their heads, that Icarius had poisoned them. The festival of Dionysus at Icaria was supposedly founded to expiate this martyr's fate, and Icaria, through Thespis, may thus be considered the historical cradle of European drama, just as medieval drama sprang in part from the Church festivals of the Passion and Nativity of Christ. It is said that Thespis carted his mummers on tour about Attica and that he took the first step to turn choral lyric into drama by introducing an actor to engage in dialogue with the Chorus or its leader. Some idea of his primitive drama may perhaps still be gained from the dithyramb of Bacchylides (c. 507-430) called *Theseus,* a kind of oratorio in which King Aegeus discusses in lyric verse with a Chorus of Athenians the rumors about an unknown young hero who has appeared on the marches of Attica and is, in fact, his own lost son.

Sir William Ridgeway tried to flout ancient tradition and prove that tragedy arose from a ritual in honor not of Dionysus but of the dead. This is the reason, he argued, for the large part played in Attic tragedy by tombs, ghosts, and sepulchral rites. In fact, he was willing to ascribe a Dionysiac origin only to the satyr drama. This view, however, has not gained general acceptance, and despite the efforts of some modern critics it seems difficult to separate the origins of tragedy and the satyr drama. In any case, Dionysus himself was one of the slain gods of ancient religion who symbolize the alternate life and death of Nature through the cycle of the year; and between the worship of a dead god who lives again and the worship of a dead hero who lives still the ultimate difference is not immense.

After Thespis, Attic tragedy developed swiftly towards its brief century of triumph—from about 500 to about 400 B.C. Thespis won his first victory in the competition at the Great Dionysia in Athens in 534, but his career may well have begun much earlier, especially if there is truth in the

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*OEDIPUS AND THE SPHINX*

FROM A PAINTING BY J. A. DOMINIQUE INGRES

story that the old statesman Solon (c. 640-560), anticipating the puritanism of Plato, the Medieval Church, and Tolstoy, denounced Thespis for daring to get up on a platform and tell lies to the public. In any case, only nine years after Thespis' first victory at Athens, there was born the first and one of the greatest of Europe's tragic masters, Aeschylus (c. 525-456), who added a second actor to the cast and thus turned tragedy definitely from lyric to drama. Now, with two actors, the dramatic clash of two personalities could begin, and since each actor could take several parts in different scenes of the same play, a more complex dramatic texture was now possible. A third actor may also have been added by Aeschylus, but it is usually Sophocles (c. 495-406) who is credited with both this innovation and the introduction of painted scenery. Sophocles is also notable for another dramatic advance, for whereas Aeschylus had written tetralogies consisting of three tragedies followed by a satyr drama, all on one consecutive theme, Sophocles wrote his four plays on independent subjects and thus was able to effect a further concentration of dramatic unity within each play. Sophocles' contemporary, Euripides (c. 480-406), basing his dramas on these structural principles, developed new tendencies—realism, romanticism, melodrama, pathos, intellectualism, humanitarianism, and rhetoric. His choral lyrics came to be more dissociated from the action of the play, but on the other hand the more elaborate music of his time found a new outlet in lyrical solos by single actors. Euripides relies less on inspiration and intuition than do Aeschylus and Sophocles, more on the critical intellect; and his general relation to his two great predecessors in some ways recalls that of Voltaire to Corneille and Racine. Less honored in his own day than Aeschylus and Sophocles, Euripides none the less exerted in later Antiquity and, partly through Seneca, during the Renaissance a wider influence than either. In the centuries after his death, Athens and then Alexandria continued to produce tragedies, but none of them has survived and none seems to have been worthy of survival.

The degree to which the future progress of European drama is already anticipated in the small fifth-century city of Athens remains astonishing, and it is all the more remarkable in view of the fact that Attic tragedy was curbed by so many more conventions and constraints than is modern drama. It was presented during a religious festival which lasted only a few days each year. With the exception of a few historical plays on recent events, like the *Fall of Miletus* and the *Phoenicians* of Phrynichus, an elder contemporary of Aeschylus, and the *Persians* of Aeschylus himself, the subjects had to be taken from an established body of heroic myths, a restriction comparable to that which a modern dramatist might face were he confined to medieval legend-cycles like those of Arthur, Alexander, and Charlemagne. The irremovable chorus of Attic tragedy, with rare and slight exceptions, also restrained the action to one place and a few hours. Verse was compulsory, and was often very complicated verse. There could be only three actors on the stage. Their faces were hidden in rigid masks. And the auditorium, though acoustically excellent, was vast enough to contain over 20,000 spectators, and these drawn from every class. Yet, despite such restrictions these dramatists mastered secret after secret of the stage: plot-construction; the clash, or the delicate contrast, of characters; the deeper dramatic interest of conflict within a character's mind; that other dramatic interest of the clash of ideas, which dominates the discussion drama of Ibsen or Shaw; tragic irony; and some measure of comic relief, not only in the burlesque satyr drama which followed the tragic performances, but also in characters like Orestes' nurse, Pentheus' messenger, or the Heracles of the *Alcestis*. They had little to learn in style, whether dialogue or lyric. They apparently composed their own music. Aeschylus and, in his youth, Sophocles were both actors. And Aeschylus, in particular, was also a master in the presentation of spectacles and crowd effects.

On the other hand it may be doubted if the admirers of Greek tragedy have not sometimes lost their sense of proportion. Aeschylus once called his plays "fragments from the great banquet of Homer," and indeed it may be felt that even in Aeschylus, and still more in his two younger rivals, some of the splendor of that Homeric banquet has passed away. It is not only that on the stage of Athens figures like Achilles, Agamemnon, Odysseus, and Helen have grown smaller and less fine than in the pages of the *Iliad* or the *Odyssey;* there is also in these Attic writers a generally narrow, less generous, less Shakespearian tolerance and understanding than in Homer. The arguments of these dramatists, and they are not always very intelligent arguments, about good and evil, right and wrong, God and man, grow at times to be tiresome compared with the quiet acceptance of the old Ionian poet, who often seems to pass over problems that vex the dramatists because he is too wise to indulge in questionings that are largely fretful and futile. The morbid guilt of Oedipus, the wranglings about the guilt of Orestes, the harshness of some of Sophocles often seem curiously primitive beside the older epic. There are times, too, when the style of Greek tragedy grows wordy, artificial, rhetorical; the line-for-line altercations of characters can become childish; and the Choruses, especially, are not exempt from a love of platitude, a preciousness of phrase, a loquacity of lamentation that make Housman's parody of Greek tragedy not

merely amusing to read but trenchant criticism as well. However it is no disgrace to be inferior to Homer. At their best, the great Attic Three have found few serious rivals, perhaps not half a dozen, in the more than two thousand years since they died.

In tragedy, as in so many literary forms, Rome faithfully followed Greece like a vast, but often dim and distorted shadow. Roman tragedy began with a Greek prisoner-of-war from Tarentum, Livius Andronicus (c. 240 B.C.), who was followed by Naevius (died c. 200 B.C.) and the more important trio, Ennius (c. 239-169), Pacuvius (c. 220-132), and Accius (c. 170-94). These last three won great acclaim in their own day, and they seem to have added to their Greek models a Roman virility, dignity, and energy that recall Corneille, but their works survive only in fragments. Lost too from the later Augustan period are the *Thyestes* of Varius and the *Medea* of Ovid, and there remain to us only the chamber dramas attributed to Nero's tutor and victim, the Spaniard Seneca (died A.D. 65), works of fourth-rate value in themselves, but, together with Plutarch's *Lives,* of vast influence on the drama of the Renaissance. In part this influence was useful. From Seneca the reviving theatre could learn again something of that Classical sense of form which the literature of the Middle Ages had largely lost. For his plays are regularly divided by their choral lyrics into five acts, whereas even in Athens the number had remained unfixed; they keep the unities of action, time, and place; their style has brevity, wit even to excess, occasional eloquence, and at least some ideas. At times this Stoic philosopher was even a poet, and descendants of the ghosts which he introduced in his plays were to people the Renaissance stage, as in *Macbeth* and *Hamlet,* with phantoms that are sometimes impressive. On the other hand Seneca's tragedies are often false, sadistic, tawdry with rhetoric and hyperbole and epigram, and thus typical examples of the cruelty of decadence, and of the havoc that unrestrained cleverness always works in poetry.

The Middle Ages had no real tragedy. The Terentian Latin dramas of the tenth-century German nun Hroswitha on Christian conversions and martyrdoms, or the Byzantine pastiches like the Χριστός πάσχων or *Passion of Christ,* of the eleventh to twelfth centuries remain mere curios. The real contribution of the Middle Ages was to prepare those elements of comedy and romance, that imaginative freedom, and that popular indifference to academic rules which were to save the drama, in Spain and England at least, from the pedantries of an overly pure Classical revival.

Italy began a long series of Renaissance imitations of Classical, and especially Senecan, tragedy with the Latin *Ecerinis* of Albertino Mussato, for which its author was crowned with laurel at Padua in 1315. Two centuries later came the first tragedies in Italian, Antonio Cammelli's *La Panfila* (1499) and Trissino's *Sofonisba* (1515), but though it has been calculated that between 1400 and 1735 Italy produced some six thousand plays and though Maffei's *Merope* (1714) is said to have run through seventy editions in his lifetime, no Italian tragedian of real distinction appeared before Alfieri (1749-1803).

In France the Classical tradition proved more fruitful. First, as in Italy, came translations of ancient tragedy or Latin imitations like those of Buchanan, in which the young Montaigne acted (c. 1540-1545). These were followed by the *Cléopâtre captive* of Jodelle (1552), who was celebrated by Ronsard and his friends with a flower-crowned goat which scandal accused them of actually sacrificing to Dionysus. In the next eighty years Garnier, Montchrétien, Hardy, Mairet, Rotrou prepared the way for Corneille, Racine, and Voltaire.

Brunetière, indeed, has claimed that only Greece and France have bred true tragedy, Shakespeare and the rest having written "drama," and it is true that in strictness of form only French Classical tragedy approaches the Greek. Indeed in some ways the French were even more rigid, for they kept strictly to five acts and to the three unities and avoided the least touch of comic relief or the slightest relaxation of ideal dignity. In Corneille the battles of will triumphant and in Racine the struggles of will overcome by passion are worked out with the logic of a chess game, and still, at their best, remain dramatic and alive. In Athens, this loftiness of tone had been maintained by the religious setting and the heroic legends taken from an aristocratic age; in France, though the drama was now condemned by religion, an aristocratic society still encouraged it as an aristocratic

*HAMLET ENCOUNTERING HIS FATHER'S GHOST*

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form. Both the Greek and the French theatres also represent the brief triumph of a highly cultivated society, for between *Le Cid* (1636) and *Athalie* (1690) lies only half a century; yet many must feel that the perfect logic with which French tragedy can develop its plots does not compensate for its loss of the lyric beauty of the Attic writing. Nor is this loss redeemed by the French insistence on love interest. Greece had used this sparingly, but in France a delight in psychological anatomies of passion had already been stimulated by such works as D'Urfé's romantic novel *Astrée* (1607-27). None the less, though the Romantics triumphed over Classicism at last, neither Hugo's *Hernani,* nor Vigny's *Chatterton,* nor Musset's *Lorenzaccio* has succeeded in surpassing Racine's *Phèdre* or *Athalie.*

England, meanwhile, had produced a type of tragedy that was characteristically far more of a compromise and a reconciliation between ancient and medieval. Here, too, in the sixteenth century, there was first an apprentice period of Classical translations and imitations, both Latin and English, such as Legge's *Richardus Tertius* (1579) or Norton and Sackville's *Gorboduc* (1561). The triumph of Kyd's *Spanish Tragedy* (1586) and Marlowe's *Tamburlaine* (1587), however, made it clear that the English theatre, as democratic as the French was aristocratic, would maintain its freedom to multiply characters, to defy the bounds of time and space, to range from the loftiest poetry to the grossest realism, in short to indulge all those liberties without which Shakespeare himself would have been frustrated in much of his greatest work. Faguet has summed the matter up by saying that Greek tragedy concentrates on aesthetic beauty, French on reason, English on life. This seems truer than most such epigrams.

But in English tragedy the period of greatness proved even briefer than in France; Marlowe's *Faustus* and Middleton's *Changeling* are separated by little more than thirty years, and though Milton's *Samson Agonistes* may be considered as extending the period somewhat, it is an isolated work that remains as lonely and aloof as its author. The revival of tragedy under Dryden and Otway was but faint—"the second temple was not like the first"—and the centuries that followed produced little tragic drama that could long hold the stage until the Irish revival under Yeats and Synge.

Renaissance Spain preserved a like freedom in the theatre and was rewarded with the dramas of Lope de Vega (1562-1635), Tirso de Molina (1571-1648), whose *El Burlador de Sevilla* first brought Don Juan on the stage, and Calderón de la Barca (1600-1681). Germany, on the other hand, came late into this field, as into many others, for little interest attaches to the work of writers like Hans Sachs, Opitz, or Von Lohenstein, "the German Seneca." Classical influences are strong in Schiller's *Braut von Messina* and Goethe's finer *Iphigenie auf Tauris,* but both poets have left much more vivid work in the freer, more Romantic style of *Wallenstein* and *Faust.*

Since the seventeenth century perhaps the only tragic master to attain some of the universality of the Greeks and of Shakespeare has been the Norwegian Ibsen (1828-1906), whose superiority to his Swedish rival Strindberg does not seem seriously in question. Though he offers certain analogies to Euripides in his intellectual independence, a Greek would find tragedy strangely changed in Ibsen's hands. In his plays poetry has almost wholly given place to prose, and kings and heroes have become photographers and town councilors. Yet in this somber twilight of the north there relive in a new shape the ancient sense of the poetry of things and the ancient precision of form and economy in art. It becomes clear, too, that the Greek classification of tragedy as serious drama is more practical than our modern stress on unhappy endings. It would be pointless to put in separate categories *The Lady from the Sea* and *The Master Builder,* or to reclassify *A Doll's House* as a different type of play when Ibsen was temporarily forced to give it a happy ending. For modern criticism "tragedy" merges into "serious drama."

Even since the fall of Neoclassicism the influence of Greek tragedy on European drama has been considerable. It has not only produced direct imitations like Goethe's *Iphigenie,* Grillparzer's *Das goldene Vlies,* Foscolo's *Aiace,* Shelley's *Prometheus,* Arnold's *Merope,* Leconte de Lisle's *L'Apollonide,* Swinburne's *Atalanta in Calydon* and *Erechtheus,* Hugo von Hofmannsthal's *Elektra,* and Wedekind's *Herakles;* but the Greek form has also left its mark on Hardy's *Dynasts,* with its Choruses and its Aeschylean sense of doom, and the Greek concentration on reflection and states of mind rather than on abundant incident reappears in the "static drama" of Maeterlinck. Greek themes, again, have been rehandled by D'Annunzio, Gide, Cocteau, and Eugene O'Neill, and finally, it must not be forgotten that opera is a lineal descendant of Attic tragedy and that Wagner was consciously attempting to revive the Greek union of music with drama, however much the musical side might have gained in complexity since the days of Aeschylus.

*FAUST AND MEPHISTOPHELES*

FROM THE GRAVURE OF A PAINTING BY A. JACOMIN

CULVER SERVICE

## THEORY

Greece not only produced the first three great European tragedians, it also produced a theory of tragedy that has had an even greater influence. Aristotle's *Poetics* is indeed a treatise on tragedy rather than on poetry. Its value lies less in its answers, for these are often obsolete, than in the questions it asks. Thus Aristotle's definition of tragedy still pro-

vides an epitome of the famous battles of dramatic criticism from that day to this. "Tragedy," he says, "is a representation of an action which is important, complete, and limited in length; it uses language made beautiful in different ways in different parts of the play; it is enacted, not recited; and by arousing pity and fear it gives an outlet to emotions of this type."

This definition requires some elucidation. By "representation" (μίμησις) is here intended a reproduction by artificial means of the feelings produced by the real experiences of life, but this definitely does not imply realism, which the Greek stage conspicuously avoided. Moreover, an "action," as the Greeks knew and as Chekhov, for example, has shown again, may consist largely of mental events, with very little physical incident. What is "important" enough for serious drama has occasioned much angry controversy. The lovers and beggars of Euripides, Macbeth's porter or Hamlet's gravediggers, Racine's emperor hiding behind a curtain, and Ibsen's *bourgeoisie* have all been denounced as lacking in tragic dignity. But for true genius few things are common or unclean; it is the tone of the whole that matters.

The "beautiful language" of Aeschylus and Shakespeare is, on the other hand, a thing of the past, which the modern prose-bound dramatist may enviously regret. He can only try to escape from conversational realism by rhythmic prose, like Synge or D'Annunzio, or by the poetry not of language but of things and symbols, like Ibsen or Chekov.

Instead of "enacted, not recited" Aristotle should have said "enacted *rather than* recited," for Greek tragedy is full of messengers' speeches. In considering this portion of Aristotle's definition we are faced with the long battle of the unities: can we follow events, leaping over time and place, or must all events outside one spot and a few hours be recounted and not performed? The real reason for the unities of time and place disappeared with the immovable Chorus, but Renaissance pedantry loved rules regardless of reasons and chose to uphold the unities on the psychologically absurd ground of realism, as if the human imagination were a snail. The blunt good sense of Samuel Johnson finally disposed of the misconception that the unities were necessary to illusion, and if modern playwrights like Ibsen have sometimes returned to a partial observance of the unities of time and place, it has been simply for aesthetic neatness and concentration: the age of the cinema cannot suppose that they are needed to create a sense of reality. Furthermore, the film can now enact situations too difficult for any stage.

Last comes the famous question of the psychological effect of tragedy. Aristotle's *catharsis,* or purgation (*not* "purification"), is a frankly medical metaphor. Plato had condemned poetry for making men too emotional; Aristotle retorts that by providing a safety-valve tragedy prevents men from becoming too full of repressed emotions. This is typical of the unascetic good sense of the Hellenes: "nothing too much," they believed, neither too much emotion nor too much restraint, and Apollo must stand beside Dionysus. But though Aristotle has answered Plato, he has not answered us: we do not go to the theatre to be purged, but because we like it. But why do we like to watch suffering? Because we are malicious, said Rousseau, just as in comedy our pleasure is indicated by malicious laughter. There is some truth in this; but it is not the whole truth, or why should an audience weep with sympathy? Schopenhauer thought that tragedy appealed by revealing the true vanity and wretchedness of life. But audiences do not consist of Schopenhauers. Hegel found tragedy satisfying because it is not really tragic at all, and life's seeming tragedies really end happily in a higher

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*Alla Nazimova in a scene from* Ghosts, *by Henrik Ibsen*

synthesis. In the *Antigone,* for example, although Sophocles would have been much astonished to hear it, Antigone and Creon are both right, but not right enough. Their destruction is therefore just, and pity, for which Hegel, indeed, had no use, would be misplaced.

For Nietzsche, the power of tragedy lay in its combination of our two impulses, the splendid Apollonian joy of creation and the dark Dionysiac lust to destroy and be destroyed. This too has its truth. But is it not perhaps enough to say that we go to see *Hamlet* or *The Three Sisters* for the sake, not of purging emotion, but of having it? We value an emotional experience because to feel more intensely, though not too intensely, is to be more intensely alive. Moreover, we gain in the theatre the wider experience of living other lives besides our own, and in this experience, which we value as we feel it to be essentially true to life, we test and deepen our own values and beliefs and sympathies. Finally, we feel, amid all the misery and folly and perversity of men, what fineness, what lovableness, and what courage are also there. In the words of Synge's Deirdre, as she stabs herself, "It is a pitiful thing, Conchubor, you have done this night in Emain; yet a thing that will be a joy and triumph to the ends of life and time."

Aristotle usefully divides serious drama into six elements: plot and character; diction and ideas; and the musical and the spectacular. The musical element provided by the Chorus is the oldest and has long vanished except in opera. From Aeschylus to Euripides we can already watch the rapid decline of the Chorus, as the tribal group from which tragedy sprang becomes less and less important and the individual more and more so. In the earliest extant play of Aeschylus

the members of the Chorus are themselves the heroines; in Euripides they fade to shadowy voices, whose lyrics provide a far-off poetic relief to the sorrows of the play's protagonists. In Elizabethan or modern drama the task of the Chorus is taken over, on the whole to advantage, by minor characters like Enobarbus in *Antony and Cleopatra,* by clowns, by First and Second citizens, by songs, by soliloquies, by confidants, or by *raisonneurs.* In Chinese drama, as in Aeschylus, a curious convention permitted the hero or heroine to act also as Chorus by singing their reflections at appropriate intervals.

Plot, Aristotle insists, must have a "beginning, middle, and end"; it must, in other words, be a well-defined, logical whole. French tragedy obeyed this rule scrupulously: Shakespeare smiled, and produced vast and illogical but magnificent excrescences like Falstaff; modern dramatists are less audacious. The most moving devices in a plot, Aristotle continues, are *peripeteia* and *anagnorisis,* which are usually mistranslated as "reversal" and "recognition." A *peripeteia* is an ironic frustration of purpose, producing an exactly opposite result from what was intended, as when Dejanira poisons her husband with the love philter that was to win him back to her or as when Lear puts himself at the mercy of the daughters that hate him and casts out the one that loves. The *anagnorisis* is wider than "recognition"; it is any "discovery" of the true situation. In other words, for Aristotle the most effective plot is that in which men's purposes are frustrated by their own blindness in a tragedy of errors, whose essence is tragic irony. The tragic error itself is Aristotle's famous *hamartia,* which may be a fault either in morals, like Antony's, or in judgment, like Othello's. Through it men ruin their own selves or those they love best, and this, as Aristotle justly points out, is more tragic than enemy ruining enemy or than the catastrophes of chance.

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*Edmund Gwenn, Gertude Musgrove, Judith Anderson, and Katherine Cornell in a scene from* The Three Sisters *by Anton Chekhov*

This analysis of Aristotle's, with its stress on the irony of things, is amazing in its quiet logic and the light it throws on serious drama from Aeschylus to Ibsen. His emphasis on plot rather than character as "the soul" of serious drama seems more dubious. Corneille and Racine might have agreed; Shakespeare would not, for his plots are often lame and are saved only by characterization and sheer poetry. A thoroughly good skeleton is, indeed, most desirable for any human being, but the very best of skeletons is a limited blessing compared with the infinite possibilities of mind and character. In Chekov or Pirandello, indeed, the "action" takes place largely in the characters' own minds.

On character Aristotle is less illuminating. Character, he stipulates, should be true to type, or, as we should prefer to say, "convincing"; it should be consistent and as good as the plot permits. Here the overmoralistic bias of ancient criticism reveals itself; yet Aristotle is objecting to needless vileness and not always without good reason. On the other hand, the hero or heroine, he thinks, should not be quite faultless, for if they are, their unhappiness will revolt us. The true objection to faultless characters, however, is rather that they are themselves unbearable and not that their sufferings are. Aristotle's insistence that characters should also be of high estate is, of course, obsolete, though French tragedy long clung to it, and may be considered a relic of those religious origins of tragedy which concerned it with gods or heroes.

The style of tragedy, according to the *Poetics,* should be clear but not mean. Too many ordinary words make it mean, too many strange words make it jargon. The saving grace is metaphor, which can lend imaginative magic even to ordinary words. Of that, Shakespeare provides a vivid example. And even though verse in drama has given place to prose, there remains deep truth in this simple precept, as may be seen in the style of Synge's peasants, who have not worn out their language as the mechanically educated have done.

On the spectacular Aristotle is brief, but sound. It has its place; but it can easily encroach. Here, also, time has only too often proved him right.

In our own day the depressing view has been put forward that modern man is too insignificant for tragedy. Ibsen has already answered this contention. It is the tragic dramatist's own greatness that matters. Fine drama remains rare because it requires not only dramatic genius but dramatic audiences and other conditions which genius by itself cannot control. Unless the tyranny of totalitarianism should degrade mankind to the mass mentality of the servile state, there seems not the slightest reason that stage and film should not still produce tragic masterpieces. But the history of twenty-five centuries has shown tragedy to be like a sour aloe that is shy to flower and quick, when it has flowered, to die again.

*See also* THEATRE; *and articles on national literatures and individual authors named.* F. L. L.

**TRAHERNE, THOMAS** [trəhɜ′rn] (c.1637-1674), English writer, was born and reared in Hereford, where his father was a shoemaker. He was educated at Oxford and in 1657 was appointed rector of Credenhill, Herefordshire. Later he became chaplain to Sir Orlando Bridgeman, the Lord Keeper, and in 1672 accompanied him into retirement at Teddington, Middlesex. There Traherne died on or about Sept. 27, 1674.

During his short, quiet life, Traherne was not known as an author, for he had published only one book, an attack on Roman Catholicism entitled *Roman Forgeries* (1673). Two other prose works published later in the century did nothing to advance his reputation. The manuscripts of his literary prose and verse were, however, miraculously preserved until their discovery in a London bookstall in 1897, and the *Poems* were finally published in 1903. The *Centuries of Meditations* appeared in 1908, and two years later another collection, *Poems of Felicity,* was published from a manuscript that had lain neglected in the British Museum.

Although the poems have received more attention than the prose, some critics believe that, because of the technical

defects in Traherne's verse, his meditations are superior. In both forms, his thought is the same: true spiritual felicity is to be found in a mystical approach to God through a child-like enjoyment of nature and of people. H. B. W.

**TRAIL,** a city in British Columbia, Canada, situated on the Columbia River, about 250 mi. east of Vancouver, and served by the Canadian Pacific Railway. Founded as a small smelting town in 1895, it was the largest smelting center in Canada in 1947 and had one of the largest nonferrous metallurgical plants in the world. Lead, zinc, silver, gold, bismuth, antimony, tin, indium, and cadmium are produced. Fertilizers are also an item of the city's factory output. Pop. 1951, 11,430. D. G. G. K.

**TRAILER COURTS. Development of the Industry.** The trailer industry was born during the depression years after 1929. The earliest trailers were crude, home-built affairs primarily used for vacation trips and occasionally for housing. The first commercial manufacture of a house trailer was undertaken in 1930 by Arthur G. Sherman, who formed the Covered Wagon Company for this purpose. Public reaction to the early trailers was not too favorable, but as the size and comfort of the mobile homes increased, so did the public demand for this new type of lodging. By 1936 there were in use 250,000 trailers, housing nearly a million people. About 60 per cent of this number appeared to have been constructed in someone's back yard. Phillip H. Smith wrote of the interest in trailers in 1938, "the dwellings were regarded as a solution to the economic problems of the day by offering an opportunity to escape the drudgery of city congestion, to elude the tax collector, to avoid the payment of rent, to seek greener pastures in other sections of the country, or to satiate the desire for a gypsy-like way of life."

The industry prospered during the 1930's and by 1940 was considered to be the fastest growing business in the United States. At this time, purchasers of trailer homes fell into three principal groups: (1) vacationers, (2) retired individuals, and (3) people engaged in migratory occupations. With more and more trailers going into use, facilities to service and park them became an absolute necessity. Thus, in the late thirties, appeared many of the country's first trailer courts.

The advent of World War II started the real boom in trailer sales. As defense plants expanded, thousands of workers who migrated to these areas were unable to find housing. Many purchased trailers. The government purchased thousands of the homes on wheels and established regular housing developments around arsenals, defense factories, and later around armed service centers in an attempt to alleviate the housing shortage. The close of World War II brought on an even greater scarcity of living quarters, accompanied by inflationary price structures. The demand for trailers was increased both by this fact and because of the rapid strides made in creating new trailer designs which offered added comfort, convenience, and luxury. The demand has increased since 1946 until there are now 900,000 trailers in active use. For 1955, production of trailers reached the all-time high of 100,000 units.

**Trailer Courts Today.** At present there are 14,000 trailer courts in the United States. There is tremendous variability in both size and quality of these courts. The average court contains 30 to 35 units and the owner's investment approximates $32,000 or $1,000 per unit. Many courts contain only 10 units, but the range is from 7 to 1,500 in privately owned operations. The largest trailer court in the world was located at the government project in Aiken, S.C. It accommodated 4,000 trailers. The Kiwanis Park in Bradenton, Fla., with its 1,500 units, is the largest privately owned court.

The quality of a court is based upon its attractiveness of appearance and the completeness of its facilities. The Mobile Homes Manufacturers Association rates the courts periodically and provides a listing of approved courts for the general public in much the same manner that the American Hotel Association and the Automobile Association of America list approved hotels and motels. Less than 50 per cent of the country's trailer courts now carry the MHMA stamp of approval.

American trailer courts are of three types: (1) the transient park, (2) the permanent park, and (3) the resort park. Theoretically all parks service transients but in reality only 75 per cent do. The transient park has a rapid turnover of customers and is usually not so elaborate as the other two. The permanent park is comparable to a housing development and the park's customers are really citizens of the community. Here, the trailer will often have its wheels removed and be placed on a permanent foundation. A percentage of the trailers may be owned by the park operator and rented just as one would rent a house. This style operation is not typical and is found primarily in college communities. The resort park is quite elaborate. Very often a swimming pool, recreation facilities, and even a shopping center will be available in addition to the usual court services. Resort courts are located principally in Florida, California, and many of the national parks.

WIDE WORLD PHOTO

*A STREET IN A TRAILER COURT, TYPICAL OF THIS KIND OF COMMUNITY*

The traveler who stops at a trailer court can be certain that electricity and water service are available, while 75 per cent of the approved courts have sewer service. Where sewer facilities are unavailable the court always provides a utility building which satisfies all the basic needs of the customer. The usual charge at a trailer court is $1.25 per day, including utilities.

The heaviest concentrations of trailer courts are in the South, the Midwest, and the Southwest. Construction workers, members of the armed services, retired people, and a rapidly increasing group that prefer trailer living as a way of life are the chief purchasers of trailers, with the fastest growing market provided by retired people.

Where communities once looked with disfavor on tourist courts, they now recognize them as an asset. The residents of these parks spend money in the community and are, for the most part, solid citizens. Recent surveys show the trailer

resident's income to be $1,500 above the per capita average for the United States, and the juvenile delinquency rate for his children to be below the national average. That this new way of life has wide appeal is attested by the fact that 3,000,000 people now reside in mobile homes. G. W. L.

**TRAILING ARBUTUS.** *See* ARBUTUS, TRAILING.

**TRAJAN (MARCUS ULPIUS TRAJANUS)** [tre′jən] (A.D. 53-117), Roman emperor, was born in Spain in A.D. 53. Trajan was adopted by Emperor Nerva in 97 and succeeded to the throne after Nerva's death in 98. Under

PHOTO BY ALINARI

*Trajan's Column, a monument of marble which rises more than one hundred feet above the court between the temple and basilica in Rome's Forum of Trajan*

Trajan the territory of Rome reached its greatest extent. His wars with the Dacians (101-106) ended with the incorporation into the empire of all Dacia, in the Danube Valley. His Parthian wars (114-116) carried the Roman standard to the Persian Gulf. As the result of other annexations, the kingdom of the Nabataean Arabs became the Roman province of Arabia, and provincial status was likewise accorded the defeated Armenians. While the condition of imperial finance was improved by the acquisition of the Dacian treasury and the revenue from the Dacian gold mines, an extensive public works program provided the empire with new roads and better harbor facilities. In addition to the new forum which Trajan built at Rome, mementoes of his reign are the famous column at Rome which commemorates his Dacian victories, and the equally well known arch at Beneventum. Despite the lack of full and original literary sources for the reign of Trajan, it is known that he was personally popular and preserved good relations with the Senate; the army was happy and contented under this competent and successful leader. A darker side of the period is seen in the increasing prestige of the executive at the expense of the Senate; the lack of initiative in the case of the provincial governors and their utter dependence on the emperor is clearly shown in letters written to Trajan by the younger Pliny, governor of Bithynia. Trajan died at Selinus, in Cilicia, Aug. 8, 117.
T. B. J.

**TRALEE** [trəli′], or Traighli, a seaport and the county town of County Kerry, Munster, Ireland, situated about 54 mi. southwest of Limerick (Luimneach), in a farming district. The town developed from a Dominican monastery established in 1213. There is a canal connecting the community with Tralee Bay, but incoming ships over 200 tons must dock at Fenit, 8 mi. westward, and the goods are shipped by rail to Tralee. There is a large trade in dairy products at Tralee. Pop. 1951, 11,045. A. W.

**TRANSCAUCASIAN SOVIET FEDERATED SOCIALIST REPUBLIC,** a federation of the Union of Soviet Socialist Republics established in 1923 and abolished in 1936.

At the end of World War I three independent countries were established in the Transcaucasian section of Asia: Armenia (Erivan), Azerbaidzhan, and Georgia. In January 1920 the Allied Powers accorded de facto recognition to them, and treaties delimiting boundaries were signed with Turkey. Although the formal independence of these countries was thereby accepted, they appeared to be under Russian control: in April the Azerbaidzhan government was overthrown by an internal revolution and replaced by a Soviet Republic; in December a Soviet government was established in Armenia; and a disturbance in January 1921 caused Russian troops to enter Georgia, where the organization of a Soviet Republic was announced in March. On Mar. 12, 1922, the three Soviet governments created the Transcaucasian Soviet Socialist Republic, an independent unit, and on July 6, 1923, the republic became the Transcaucasian Soviet Federated Socialist Republic, one of the four original federated republics in the Union of Soviet Socialist Republics. The area of the federated republic was 71,300 sq. mi. Under it were organized the Nakhichevan Autonomous Soviet Socialist Republic, the Nagorny Karabakh Autonomous Oblast, the Abkhazian and Adzhar Autonomous Soviet Socialist Republics, and the South Ossetian Autonomous Oblast. In December 1936 the federation was dissolved, largely because of stress arising from its ethnographic complexity, but the three constituents remained in the Soviet Union as individual republics. Their combined area, however, is spoken of today as Transcaucasia.
D. L.

**TRANSCENDENTALISM** [tra′nsɛndɛ′ntəlɪzəm], a philosophical theory that postulates the existence of realities which, though they are beyond the reach of the senses and the understanding, the mind may nevertheless apprehend by direct intuition. "Transcendentalism" is most commonly used in America, however, to designate a cultural and philosophical movement that flourished in New England during the second and third quarters of the nineteenth century. The movement is indirectly and loosely traceable to German idealism, but it has its deeper roots in a revolt against the skeptical implications of classical British philosophy. Although sporadic traces of it can be discovered during the first quarter of the century, its first coherent expression is found in James Marsh's introduction to the first American edition of Samuel Taylor Coleridge's *Aids to Reflection,* in

1829. Marsh, who had some acquaintance with German philosophy, elaborated a distinction between the understanding and the reason somewhat after the manner of Immanuel Kant.

In the summer of 1836 a few young men, including Frederic Henry Hedge, George Ripley, Amos Bronson Alcott, and Ralph Waldo Emerson, joined together with the avowed purpose of finding a more satisfactory basis for their beliefs than the "sensualism and materialism" of Locke. This little group came to be called the Transcendental Club, and in the next three or four decades most of the literary, philosophical, social, and religious leaders of New England were connected in one way or another with the movement. The literature of American Transcendentalism consists of poetry, fiction, orations, sermons, and essays.

Ralph Waldo Emerson, who became the acknowledged leader and spokesman of the movement, was the descendant of a distinguished line of New England ministers and was, in a sense, a product of the New England Puritan church tradition. Instead of pursuing an ecclesiastical career, however, he resigned his pulpit in 1832 for doctrinal reasons and settled in Concord, Mass., for the remainder of his quiet and contemplative life. In 1836 he published his first work, *Nature*. In this brief prose poem the reader finds little information about nature. Instead, he is introduced to the doctrine that man, through his inner perceptions, is one with all men; all men are one with nature; and nature is one with God. This was the theme of Emerson's poems and essays throughout the remainder of his life. He had found a text suited to his thought that truth is the expression of spiritual or personal insights rather than a deduction from premises provided by history and science. Transcendentalism is, thus, essentially a moral philosophy. In proclaiming the dignity of the individual man, it cut the roots of institutional tyranny and turned the mind to imagination, hope, exploration, and self-reliance. Transcendentalism also had a socialistic strain, which established a bond between many Transcendentalists and the various social, political, and religious reform movements of the day, but in Emerson's thought, and in that of his friends Henry David Thoreau and William Ellery Channing, socialistic ideas were strictly subordinate to a radical individualism. H. G. T.

**TRANSCONA** [transko'nə], a town in Manitoba, Canada, served by the Canadian Pacific and the Canadian National railways, 7 mi. east of Winnipeg, of which it is a suburb. It is an important railway center, and large shops of the Canadian National Railways are in the town. Other industries include an explosives plant, a malting factory, and grain elevators. It is the site of two power stations. Pop. 1951, 6,752. L. G. R.

**TRANSFORMERS,** stationary apparatus for transferring electrical energy from one alternating-current circuit to another without change of frequency, through the medium of a magnetic field. The transformer may step up the voltage (step-up transformer), it may step down the voltage (step-down transformer), or the energy may be delivered at the same voltage as that at which it is received (one-to-one transformer). Transformers have a high efficiency, from 97 per cent in the smaller ratings to over 99 per cent in the higher ratings; they are rugged, and the cost per kilovolt-ampere is relatively low.

The transformer consists of a core made up of laminations, usually of silicon steel (*See* Fig. 1). There are two windings on the core, the primary $P$ and the secondary $S$. For simplicity, the windings are shown on separate sides or legs of the core. Actually, with this arrangement there would be considerable magnetic flux (lines of force) linking one winding but not the other, with a consequent loss of flux called leakage flux. With this arrangement the transformer would regulate poorly. In practice, the primaries and secondaries are located close together, as in Fig. 2.

In Fig. 1 alternator $A$ supplies an alternating current $I_0$ at voltage $E_1$ to the primary winding $P$. At the instant shown, the current in the upper conductor is positive and increasing, and the primary winding produces a flux $\phi$ in a clockwise direction around the core. This flux $\phi$ which links both windings is called the mutual flux, the alternation of which induces an electromotive force (e.m.f.) in both the primary and the secondary. The e.m.f. induced in the primary is a counter e.m.f. which opposes current entering the primary and corresponds to the counter e.m.f. of a motor. The e.m.f. induced in the secondary is available for delivering energy from the secondary and corresponds to the e.m.f. of a generator.

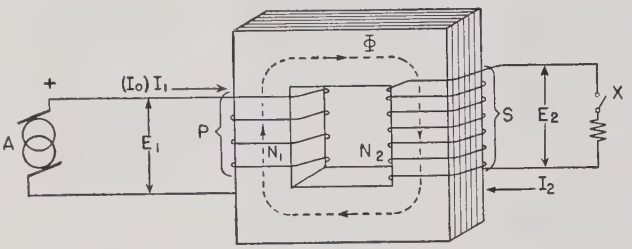



*Fig. 1—PRINCIPLE OF THE ELEMENTARY TRANSFORMER*

The induced e.m.f. in a transformer winding is given by $E = 4.44\,\phi_m f N \phi\ 10^{-8}$ volts, where $\phi_m$ is the maximum instantaneous value of the flux $\phi$ in maxwells, $f$ is the frequency in cycles per second, and $N$ is the number of turns. Since $\phi_m$ is common to both windings, it follows that the induced e.m.f. in each winding of a transformer is proportional to its number of turns. That is:

$$\frac{E_2}{E_1} = \frac{N_2}{N_1}.$$

In the usual transformer, the terminal voltages differ from the induced e.m.f.'s by only a few per cent, so that for most practical purposes the terminal voltages are practically proportional to their numbers of turns, $V_2/V_1 = N_2/N_1$.

The current $I_0$ which flows at no load produces the flux $\phi$ and in conjunction with the impressed voltage supplies the eddy-current and hysteresis losses in the core. At no load, the primary copper loss $I_0^2R$ is negligible. The current $I_0$ is called the exciting current and is usually 1 to 2 per cent of the rated current of the transformer, although in 25-cycle transformers it may reach 5 or 6 per cent.

If the switch $X$ in the secondary circuit of Fig. 1 is closed, the secondary delivers current. By Lenz's law, the direction of the secondary current is such as to oppose the flux $\phi$. When the flux $\phi$ is reduced, the primary counter e.m.f. $E_1$ is reduced and more current flows into the primary to supply the power which the secondary delivers. The counter e.m.f. $E_1$ differs from the impressed voltage $V_1$ by only 1 or 2 per cent. $V_1$ is constant. If $E_1$ remains essentially constant, the mutual flux $\phi$ remains essentially constant, and hence the net ampere-turns acting on the core remain essentially constant. Thus, the secondary ampere-turns which are added when load is applied to the secondary must be balanced by opposite and practically equal primary ampere-

turns. The exciting current is small compared with the load currents and is usually well out of phase with them. Hence, it may be said that the primary and secondary ampere turns are opposite and equal; that is:

$$N_2 I_2 = N_1 I_1, \quad \text{and} \quad \frac{I_2}{I_1} = \frac{N_1}{N_2}.$$

Thus, in a transformer the currents are practically inversely proportional to the turns in their respective windings.

**Regulation.** Fig. 2 shows a sectional view of one leg of a transformer with the associated primary and secondary coils *P* and *S*, the primary lying outside the secondary. Even though the coils are wound close together there is a certain amount of flux $\phi$, which is produced by the primary current and which encircles or links only the primary coil *P;* this is called the primary leakage flux. Similarly, there is a secondary leakage flux. These two fluxes produce reactance

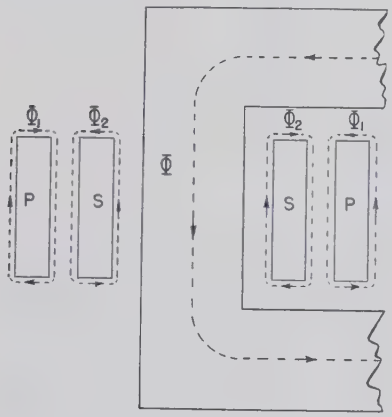



*Fig. 2—SECTIONAL VIEW OF ONE LEG OF A PRACTICAL TRANSFORMER*

drops in their respective windings, which in combination with the resistance drops decrease the secondary terminal voltage with application of load.

The primary and secondary resistance are reactances which can be used individually, or they can be combined into a single equivalent resistance and a single equivalent reactance referred to either side in determining the regulation. Thus, in Fig. 3, $V_1$ is the primary terminal voltage, and $I_1$ is the primary current lagging behind, $V_1$ by $\theta$ degrees. $I_1R_{01}$, in phase with $I_1$, and $I_1X_{01}$ in quadrature (displaced by 90 deg.) with $I_1$ and leading, are added vectorially to $V_1$ to obtain $E_1$. The value of $E_1$ is then:

$$E_1 = \sqrt{(V_1 \cos\theta + I_1R_{01})^2 + V_1 \sin\theta \mp I_1X_{01})^2} \text{ volts.}$$

With leading current the minus sign is used. In the case of unity power factor $\cos\theta = 1$ and $\sin\theta = 0$. The regulation is:

$$\frac{E_1 - V_1}{V_1}.$$

When referred to the secondary, $R_{02} = R_{01}(N_2/N_1)^2$; $X_{02} = X_{01}(N_2/N_1)^2$. The foregoing equation then may be employed, using secondary voltages and currents that give the same regulation. The resistance and reactance drops range from about one to three per cent of the terminal voltage and in Fig. 3 are exaggerated for clarity.

The efficiencies of transformers are so close to unity that poor precision is obtained if direct measurement of output and input is made. A more precise method is to compute the efficiency input from the losses, determining the core loss $P_c$ by measuring at no load the power to either winding when that winding is operating at rated voltage. The efficiency ($\eta$) then follows as:

$$\eta = \frac{V_1 I_1 \cos\theta}{V_1 I_1 \cos\theta - I_1^2 R_{01} - P_c} = \frac{V_2 I_2 \cos\theta}{V_2 I_2 \cos\theta - I_2^2 R_{02} - P_c}.$$

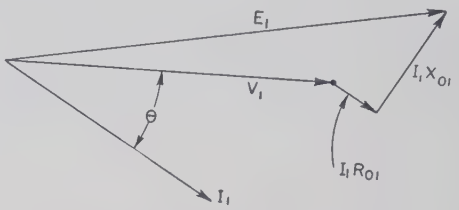



*Fig. 3—VECTORIAL REPRESENTATION OF REGULATION*

**Autotransformers.** An autotransformer is defined as a transformer in which part of the winding is common to both the primary and secondary circuits. When the ratio of transformation is low, considerable saving in cost and an increase in efficiency over the conventional two-winding transformers are obtained.

Fig. 4 (*A*) shows a 2:1 autotransformer. Unity power factor is assumed, and losses and exciting current are assumed to be negligible. The winding *ac,* continuous on a transformer core, may be split into two or more coils on opposite legs of the core. To obtain a 2:1 ratio, a tap *b* is taken from the mid-point of the winding *ac,* and the secondary load is connected between the points *bc*. For power transformation, the winding *ab* is the primary and the winding *bc* the secondary. Assume that the load current *I* is 20 amp. at 50 volts. A current of 10 amp. flows from *a* to *b* and thence to the load *dd'*. The power, represented by the current of 10 amp. dropping 50 volts, is 500 watts, which goes into the magnetic field in the core and reappears by raising

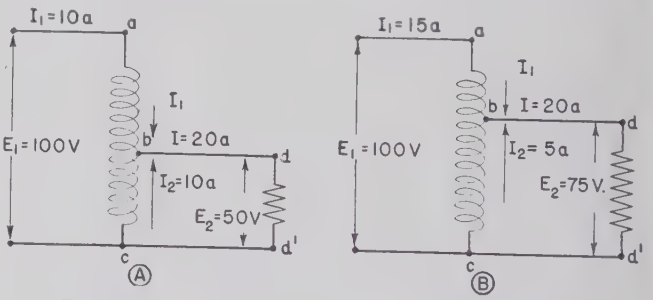



*Fig. 4—TRANSFORMER ACTION IN AN AUTOTRANSFORMER*

the 10 amp. $I_2$ by 50 volts from *c* to *b*. Hence, of the total power to the load of 1,000 watts, 500 watts flows conductively from *a* to *b* without transformation, and 500 watts is transformed. With the usual two-winding transformer not only would the winding *ac,* rated at 100 volts and 10 amp., be necessary but also a secondary winding rated at 50 volts and 20 amp. having an equal amount of copper would be necessary. Moreover, with a single winding, less iron is required for the core. Hence, in the autotransformer with a 2:1 or 1:2 ratio, the material required is half that for the usual two-winding transformer, and the losses are also about one-half.

Fig. 4(*B*) shows an autotransformer with a 100-volt primary and a 4:3 ratio. The secondary load is 20 amp. at 75 volts, so that the output is 1,500 watts. Hence, the primary current must be 15 amp. The tap *b* is located at a point corresponding to three-fourths the number of turns

from $c$ to $a$. A current of 15 amp. flows from $a$ to $b$ and thence to the load $dd'$. This current, in dropping 25 volts from $a$ to $b$, gives $15 \times 25$ or 375 watts to the magnetic field, and reappears in raising 5 amp. by 75 volts from $c$ to $b$, corresponding to a power of 375 watts. Hence, in this transformer only 375 watts are transformed, and the remainder, 1,125 watts, flows conductively from the 100-volt to the 75-volt circuit. Therefore, this transformer need be only one-fourth the rating of the usual two-winding transformer that would transform all the power.

If $n$ be the ratio of low-voltage to high-voltage e.m.f., the ratio of the power transformed to the total power delivered is $(1 - n)$. Hence the ratio of the rating of the autotransformer to the usual two-winding transformer is $(1 - n)$. Thus, in Fig. 4($A$), $n$ is equal to $\frac{1}{2}$ and the rating of the transformer is $(1 - \frac{1}{2})$ or one half that of the usual two-winding transformer. In Fig. 4($B$), $(1 - n) = (1 - \frac{3}{4}) = \frac{1}{4}$, and the rating of the autotransformer is one fourth that of the usual two-winding transformer.

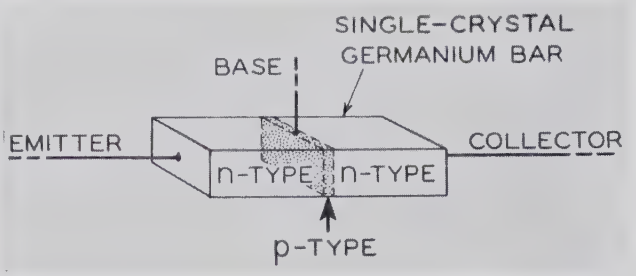
Autotransformers are used in power systems to effect transformations of moderate ratio, such as 2:1 or 1:2. They are also used for motor starters, for "balance" coils, and for innumerable other purposes in which moderate power ratios are sought.

**Instrument Transformers.** It is difficult to make measurements at high voltages, since high-voltage instruments are expensive and usually unwieldy, "static" may affect the accuracy, and there is danger to the operator. When the current exceeds 60 amp., it is difficult to construct accurate-reading ammeters on account of the large wires, and the errors due to the stray field of the leads become too large. Also, ammeters and current coils in high-voltage circuits are dangerous to the operator and are subject to "static" errors. By the use of potential and current transformers, the instruments are insulated from the high voltage and voltage coils rated at 110 volts, and current coils rated at 5 amp. can be used. The secondaries should be grounded as shown. Unless the scales of the instruments are calibrated in terms of the transformer ratios, the voltmeter reading must be multiplied by the potential-transformer ratio, the ammeter reading by the current-transformer ratio, and the wattmeter (and watt-hour meter) reading by the product of the potential- and current-transformer ratios. C. L. D.

**TRANSISTOR,** a solid electronic device, capable of performing most of the functions of a vacuum tube and of operating on very small amounts of power. It was called a transistor because it is a re*sistor* or semiconductor device which can amplify electrical signals as they are *trans*ferred through it. Semiconductors are neither good conductors of electricity as are the metals (copper and silver), nor are they good insulators, like rubbber.

The word "transistor" is now used as a generic term for an ever-growing family of semiconductor amplifiers. Although transistor technology is undergoing rapid change, the basic theory which resulted in the invention of the device remains the same.

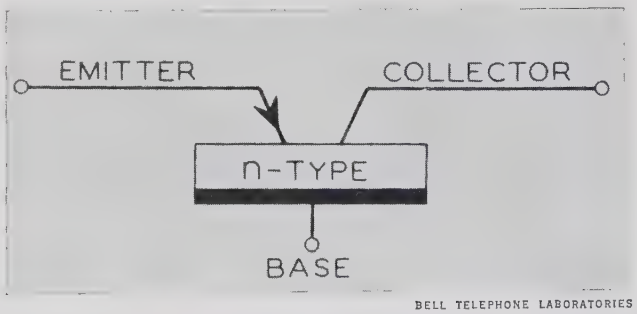
This device was invented at Bell Telephone Laboratories in 1948 by John Bardeen and Walter H. Brattain. It was not discovered by "accident." William Shockley, a physicist, had predicted the possibility of controlling the meager supply of movable electrons inside a semiconductor by influencing them with an electric field imposed from the outside without actually contacting the material. The first type of transistor to be developed is now called a point-contact transistor. It consists of two thin wires spaced a few thousandths of an inch apart and resting on a tiny wafer of germanium. The flow of current in one of the fine points controls the flow in the other.




*THE POINT CONTACT TRANSISTOR*

Shortly after the invention of the point-contact transistor, the "junction" transistor was predicted theoretically by Dr. Shockley. Its development was announced by Bell Telephone Laboratories in 1951. This type of transistor can be built to occupy only about 1/400 of a cu. in. and can operate on less power than the original point-contact device. It consists essentially of a tiny sandwich of germanium or silicon, treated so that alternate layers have different electrical properties. The boundaries, or junctions, between the regions in the crystal serve the same functions as the two points in a point-contact transistor.

A crystal of silicon or germanium with a perfect electron-pair bond structure would normally act as an insulator. In order that conductivity of the electric current may occur, imperfections are necessary in the atomic structure of the crystal. These are introduced in the form of atoms of materials, such as boron, arsenic, and indium, and may amount to as little as one part in 100,000,000. Depending on the impurity used, the crystal may then have an excess of electrons or a deficiency of electrons. The first is called the $n$-type transistor—$n$ for negative—since the electron is a negatively charged particle; the second, the $p$-type—$p$ for positive.

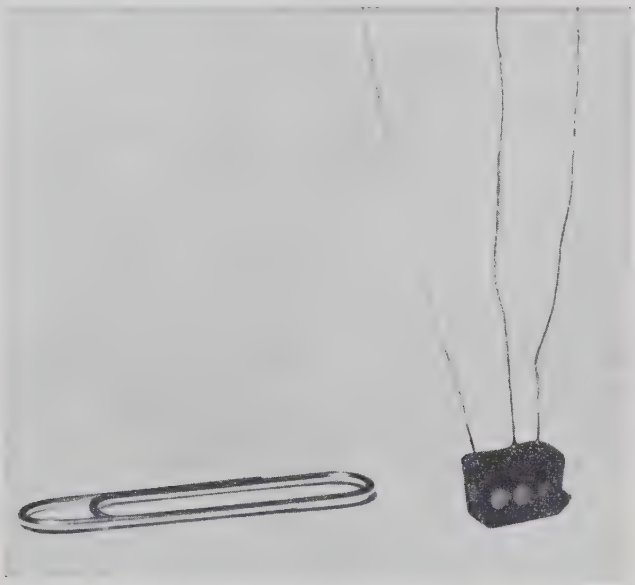



*THE* n-p-n *JUNCTION TRANSISTOR*

Most of the electrons in a semiconductor do not contribute to carrying the current at all. They are held in fixed positions and act as a rigid cement to bind together the atoms in a solid. If, however, one of these electrons gets out of place or if another electron is introduced in one of a number of ways, current can be carried. Also, if one of the electrons normally present in the "cement" is removed, the "hole" left behind it can move like a bubble in a liquid and, thus, carry current.

The transistor is much smaller than electron tubes of equal power capability. Like electron tubes, it will serve as an amplifier or an oscillator. The advantages in its use are that it is rugged, with a long life expectancy, and that

it has no grid, no plate, and no cathode. Lacking these elements, the transistor will operate instantly without the need for a warm-up period.



BELL TELEPHONE LABORATORIES

*THE JUNCTION TRANSISTOR COMPARED IN SIZE TO A PAPER CLIP*

**TRANSIT,** in astronomy and geodesy a term used in several meanings. (1) The transit of a celestial body is usually its passing over the observer's meridian. Upper transit is the crossing over the meridian passing through the zenith; lower transit is the crossing of the antemeridian, or meridian passing through the nadir.

(2) In general, transit is also the crossing of a body over an apparently larger body, as the transit of Venus over the sun's disk.

(3) In geodesy, transit refers to an engineer's instrument for surveying work. A larger and more elaborate instrument used in observatories is the transit instrument. This is a precision instrument, used for observing star transits across the meridian to determine time. H. S. R.

**TRANSITION ELEMENT,** a term applied to three groups of elements in which there is a change in an inner rather than an outer electron shell as the atomic number increases.

The first transition series runs from scandium, element number 21, to zinc, element 30. The structure for scandium is $1s^2 - 2s^2 - 2p^6 - 3s^2 - 3p^6 - 3d^1 - 4s^2$; and the number of 3d electrons increases as follows: $Sc = 3d^1$; $Ti = 3d^2$; $V = 3d^3 4s^2$; $Cr = 3d^5 4s^1$; $Mn = 3d^5 4s^2$; $Fe = 3d^6$; $Co = 3d^7$; $Ni = 3d^8 4s^2$; $Cu = 3d^{10} 4s^1$; $Zn = 3d^{10} 4s^2$. Excepting the abnormalities of chromium and copper, the members of this transition series differ essentially in the number of 3d electrons. There is a gradual change in some physical properties: the density rises from 2.5 for scandium to 8.9 for copper; the m.p. falls from 1,800° for Ti to 1,220° for manganese; the ionization potentials are between 6.7 and 7.8. The readiness of shifting the 3d level electrons results in most compounds in this series being highly colored. The elements are characterized by variable valence; probably for this reason they are useful catalytic agents, since the mechanism of catalysis often involves a change in valence. The transition elements iron, cobalt, and nickel in Group VIII of the periodic table are particularly similar in properties, although iron tends to exist in the ferr*ic* state, cobalt as *-ous* and *-ic,* and nickel only as *-ous.* These three elements are intermediate between chromium and manganese, on the one hand, in which all the 3d or transition electrons may be removed, as in chromate and permanganate; and copper and zinc, on the other hand, in which one or none, respectively, of the 3d electrons may be taken away.

The second transition series runs from yttrium, element 39, through cadmium, element 48. In these the number of 4d electrons is increasing with certain abnormalities, from 1 through 10.

The third transition series begins with the rare earths or lutetium, element 71, and runs through mercury, element 80. In these, the 5d level is increasing with certain abnormalities from 1 to 10.

Many interesting interrelationships exist between elements of these three transition series. They are characterized by variable valence, colored compounds, and ability to form coordinate compounds such as the ammine complexes. The +6 compounds of iron, ruthenium, and osmium resemble those of chromium, molybdenum, and tungsten. Nickel, palladium, and platinum resemble copper, silver, and gold. The textroxides of ruthenium and osmium are volatile. Nickel, palladium, and platinum absorb hydrogen in large quantities. *See also* ATOMIC STRUCTURE; PERIODIC TABLE.

H. N. A.

**TRANSJORDAN,** now called **JORDAN,** a kingdom in the Near East, at the northwest corner of the Arabian peninsula. Transjordan was so named because it originally comprised the region directly east of more populous Palestine and the Jordan area; the name became a misnomer as a result of the country's claim to areas not "across" (*trans*) the Jordan, but on both sides of that river. Jordan's status as a nation derives from the recognition by the French government in 1920 that it was not part of their mandate of Syria, but was instead part of the British mandate of Pales-

GROEBLE FROM BLACK STAR

*The terraced city of Amman, capital of Transjordan, is built on seven hills on the western edge of the Arabian Plateau.*

tine; and from the acceptance of an offer by Great Britain, later in that year, of the designation as ruler or emir to Abdullah ibn-Husein, son of King Husein of the Hejaz and brother of King Faisal of Iraq.

Jordan has an estimated area of 45,000 sq. mi. From north to south it is 235 mi. in length, and from east to west it is 250 mi, at the widest point and about 100 mi. at the narrowest. On the north the kingdom is bounded by Syria; on the east by Iraq and Saudi Arabia; on the south by Saudi Arabia and the Gulf of Aqaba (an arm of the Red Sea); and on the west by Israel. For administrative purposes Jordan is divided into several districts: Ajlun (ancient Gilead) in the north, east of the Jordan River; Belqa (ancient Amman), south of Ajlun and containing Jordan's capital, Amman; Kerak (ancient Moab), farther south; Ma'an (ancient Edom), the southermost region; the Desert Area (under the control of the Arab Legion), east of these districts; and Palestine (which was incorporated into Jordan in 1950), the area west of the Jordan River and the Dead Sea.

## GEOGRAPHICAL FEATURES

**Topography.** Jordan is an elevated plateau above the escarpment of the Jordan River and the Dead Sea and has an altitude varying from about 1,500 to 5,000 ft. Except for the western fourth of the country the land is extremely arid and consists of steppe and desert. The western area, which is roughly that west of the Hejaz Railway, has agricultural potentialities. During Roman times it was the most productive area, and with more and better irrigation it could become so again.

**Climate.** Western Jordan has, in general, a Mediterranean climate. The rains come from October to May, with rainless summers, although the prevailing westerly winds moderate the climate throughout the year. In the Jordan Valley the temperatures range from 50° to 105° F. On the plateau to the east the range is from 35° to 95° F., and in the eastern desert temperatures range according to the season from 32° to 105° F. Some places on the plateau receive as much as 30 in. of rainfall each year although the annual rainfall for the entire plateau area is from 14 to 16 in. This tapers off to the east until in the desert many areas receive about one inch per year. In the higher areas snow falls nearly every winter.

**Soil.** The soil is generally fertile, but the scarcity of water and the seasonal rainfall make agriculture very dependent upon irrigation. Thousands of acres could be opened to agriculture if all irrigation possibilities were developed.

**Minerals.** The greatest mineral resources of Jordan are contained in the waters of the Dead Sea, the salinity of which is about eight times that of ordinary sea water. It is estimated that the total quantity of the chief minerals in solution are: magnesium chloride, 22,000,000,000 tons; sodium chloride, 11,000,000,000 tons; calcium chloride, 6,000,000,000 tons; potassium chloride, 2,000,000,000 tons; and magnesium bromide, 980,000,000 tons. Other known or proven mineral deposits are not very great. In the Ajlun region there are iron ore deposits of about 200,000 tons, but transportation facilities are lacking. Small amounts of copper, magnesium, ochre, bitumen, and oil exist but hardly in workable quantities. Phosphates, gypsum, marble, and industrial sands and clays are not extensively utilized.

**Fauna.** Wild boars and ibex are found in the gorges, while south of the Dead Sea may be found the hare, jackal, fox, wildcat, hyena, wolf, and a few panthers. Wild fowl such as partridges and pigeons are plentiful. The desert and steppe regions to the east have little game although some gazelles are occasionally seen.

## ETHNOLOGY AND POPULATION

Almost the entire population of Jordan is Arab. Those now settled in villages and on farms are the descendants of nomadic Arabs who have drifted in from the eastern desert

throughout the course of history. The Arabic tongue is spoken, and Islam is the state religion.

There has never been an official census of Jordan, for the people rebel against an enumeration since the procedure is too similar to the registering for taxation and army service under the Ottoman government. Following the annexation of eastern Palestine, Jordan's population in November 1950 was estimated at 1,367,000, comprising 464,500 native Jordanese, 102,500 refugees east of the Jordan, and 800,000 inhabitants and refugees in West Jordan. Of these, 15,000 are Shiite Moslems and 30,000 Christians belonging to various rites, almost all of whom speak in the Arabic tongue. Oddly enough, there are several Bedouin tribes that subscribe to Christianity, but in many ways, even to the practice of polygamy, they are practically indistinguishable from the neighboring Moslem tribes.

The steppe and desert land of Jordan, except for a few instances, is uninhabited during the greater part of the year. The inhabited area, west of the Hejaz Railway, has a population density of about 100 per square mile. The population is divided roughly into four groups: 40,000 Bedouins; 120,000 seminomads; 500,000 refugees; and 700,000 townsmen and villagers. The chief towns and their estimated populations are Amman, 108,000; Old Jerusalem, 75,000; Irbid, 23,000; Es Salt, 15,500; and El Kerak, 5,500. In northern Belqa and in Ajlun the townsmen and settled villagers predominate, and the customs are those of the agriculturist. In southern Belqa and in Kerak the seminomadic element is more numerous, but under the security established by the Abdullah government the old tribal system is beginning to break down, Ma'an and the eastern desert region remain the realm of the Bedouin.

## GOVERNMENT AND POLITICS

**Central Government.** The Hashimite Kingdom of Jordan is ruled by King Husein. In accordance with the treaty with Great Britain establishing Transjordan's independence, constitutional government was adopted, and the newest constitution went into effect in 1952, having been approved by the legislative assembly and the king. The executive power is in the hands of the cabinet, which is responsible to the assembly and may be ousted by a two-thirds vote of that body. The assembly consists of two houses. The House of Notables, consisting of twenty-four members, is appointed by the king, and the House of Deputies of forty members consists of the cabinet members and representatives elected by all males who are nonnomadic and over eighteen years of age. The courts are presided over by judges appointed by the king, and jurisprudence is based on Moslem law. The chief *qadi,* or judge, is regarded as a member of the cabinet ex officio.

**Political Parties.** Political parties as such did not exist in the kingdom before 1950, when an opposition party was allowed to form. Local leaders and tribal sheiks have followers and political power, but they were never able to exercise any real independence during the strong rule of King Abdullah.

**Finances.** The finances of Jordan operate under peculiar circumstances. Large portions of usual government expenses for education, public health, and armed forces are financed by foreign, religious, and charitable institutions and by the British government. About five sixths of the cost of maintaining the Jordanian Frontier Force is met by funds from the treasury of Great Britain. In addition, Great Britain in various grants-in-aid contributes about 50 per cent of the total of the annual governmental budget. The most important tax in Jordan is the land tax; others are an animal tax, a house and land tax on urban property, an income tax, excise and stamp taxes, and custom duties.

The Jordan dinar is the monetary unit, and it is divided into 1,000 mils. The dinar is tied to and equivalent to the British pound sterling and was devalued in 1949 when the ratio of sterling to the dollar was changed. Gold coins of every mint are also in circulation although most of these are British sovereigns and Turkish gold pounds. Since the Arabs do not value copper coins, the smallest coin in circulation is the nickel five mils piece.

Jordan has no real public debt, having paid off its share of the old Ottoman debt in 1946. This debt actually was paid by a loan-in-aid received from Great Britain, but no one expects it ever to be repaid. In Jordan it has been looked upon as one of the many grants-in-aid made by the British each year. Such grants total between £2,000,000 and £3,000,000 annually in addition to special military grants, which often surpass that amount. However, grants for hydrographic surveys and for the construction of the Jordanian portion of the Haifa-Baghdad Highway are examples of other British contributions which have been made explicitly "to cover legitimate expenditure which the territory was unable to meet with its unaided resources." In addition, in 1952 Jordan received $3,780,000 under the United States Point Four program, to be spent on farming, health, sanitation, education, and transportation; and in 1954 is received $8,000,000 from the United States for economic aid.

**Armed Forces.** The trained armed forces of Jordan consist of the Jordanian Frontier Force and the more publicized Arab Legion. These are largely subsidized and equipped by the British and number more than 20,000. The Legion is empowered to act beyond the Jordan frontier, and it was this force which broke the Nazi-inspired *coup d'état* in Iraq in 1941. Its strength was never utilized at the time of the partition of Palestine.

## ECONOMIC ACTIVITIES

**Agriculture.** Agriculture, in general, follows the same methods used since the beginning of historic times, though various improvements in seed and irrigation projects have increased the total yield of the crops. Wheat, barley, and millet are the chief crops and since 1937 Jordan has had quite an exportable surplus. Beans, peas, and lentils are the main leguminous crops. The farmers along the Jordan River, however, have in recent years turned in part to the cultivation of vegetables such as tomatoes, cabbages, eggplant, cucumbers, potatoes, squashes, and melons. Jordan has long been a land that cultivated olives and grapes. As in Roman times, the grapes, raisins, and wine of Ajlun and Belqa are exported to Palestine and beyond the sea. Olives and olive oil are also exported. Tobacco, sesame, apricots, bananas, lemons, pomegranates, almonds, and figs are grown in smaller amounts and mainly for local consumption. The Bedouin and the seminomads raise sheep, goats, camels, horses, donkeys, and a few cattle. These are raised for food as meat and for work animals. Since 1930, however, the increased number of motor vehicles, especially trucks, has depressed the market for camels, and the Bedouin has been hard pressed financially.

**Mining.** The only significant mining in Jordan is that done by the Palestine Potash Company which holds a concession to exploit the minerals in the Dead Sea until the year 2005. The principal products have been potash and bromine, and in some years this Anglo-Jewish concern has extracted over 100,000 tons of various salts. In 1950 the

utput was low because of the heavy damage done to the nstallations during the Palestinian war.

**Industries.** Jordan has virtually no industries. Two obacco factories in Amman employ several hundred people nd produce solely for the local market. There are three rude distilleries, a small textile factory, and a few olive resses in the country, but in the main the requirements of ordan are still met by home industry and imports.

**Fisheries.** The Gulf of Aqaba abounds in edible fish, but very attempt to exploit this resources has failed. A good narket for fish exists in Israel and Jordan, but transport of he catch has never been organized and developed.

**Trade.** Jordan's export trade consists almost entirely of ivestock and agricultural products, delivered chiefly to raq, Israel, Syria, Saudi Arabia, and Egypt. Textiles are he chief import, and the prewar market, mainly Japanese, as been supplanted by Britain, Lebanon, and Syria. Commerce is handled primarily by individuals or by families in artnerships, and much of the trade is arranged through eighboring markets, such as Baghdad, Damascus, Beirut, Haifa, and Alexandria. Banking is in a primitive state. The Ottoman Bank of Paris is the government bank, and cts as a currency-issuing authority. Other banks engage in he transfer of funds and in foreign exchange.

**Communications.** Jordan is a member of the International Postal Union and mails are dispatched via Syria, Iraq, Israel, and Egypt. The principal towns are connected by elephone and telegraph, and extend to the neighboring countries. These facilities are largely used by the government and imited in service to the public. A number of all-weather roads have been constructed since 1936 when the British government began many grants-in-aid for this purpose. Roads east-west and north-south through Amman to the frontiers have been built and about 210 mi. of the modern Haifa-Baghdad Highway traverses Jordan, the chief town on this road being Irbid which is developing into a commercial center. The only railroad in Jordan runs from Nassib to Ma'an, a distance of 200 mi., and is part of the Hejaz Railway which operated only before World War I. It is little used and only one train each week operates over the Amman-Ma'an section. It incurs a considerable yearly deficit and probably never will be profitable until Jordan becomes more developed. The British Royal Air Force maintains landing fields at Amman and Ma'an, and the Iraq Petroleum Company has one at its pumping station in the eastern desert. A large air field, recently constructed at Mafraq in the north, at a cost of £2,500,000, has become one of the most important airports of the Near East. Two Jordan airlines serve Amman and Jerusalem, linking them with Beirut, Cairo, Aden, and Baghdad.

## EDUCATION AND SOCIAL CUSTOMS

**Education.** Half of the inhabitants of Jordan are illiterate. Every town and major village has a school, but applicants are turned away each year for lack of buildings and teachers. Education is free, but it is not compulsory. There are about 750 schools, with some 3,000 teachers and about 125,000 pupils. Advanced students are sent abroad.

**The Family.** In the villages and towns the important unit of society is the family, and all social life revolves around it. Among the seminomads and Bedouins, the tribe with a sheik at its head functions much as it did in early Biblical times, although the more the farmers become involved in agriculture the less they adhere to tribal organization. As this trend continues and various of the Bedouin tribes become settled, the old customs of the desert will disappear.

## HISTORY

The land east of Palestine, between the Jordan River and the barren deserts farther eastward, has experienced considerable prosperity in several historical periods. Known in Biblical times as Gilead and the kingdom of Moab, under Antoninus Pius as Arabia Petraea, and as an important province in Byzantine, Ommiad, and Abbassid times, Transjordan was one of the granaries of the world. After the conquest of that general area by the Ottoman Turks in 1516, Transjordan was relatively unimportant and became a part of the vilayet (province) of Syria.

SCOFIELD FROM EWING GALLOWAY

*A BEDOUIN FALCONER OF THE DESERT OF EASTERN TRANSJORDAN*

**Post-World War I.** Included in the unified Arab state which was promised to Grand Sheriff Husein ibn-Ali for his participation in the Arab revolt against the Turks during World War I, Transjordan became in 1920 a part of the Syrian state proclaimed from Damascus by a congress of Arab notables. Faisal, Husein's son, was chosen king. French armed forces, however, compelled Faisal to quit Syria, but the French never occupied Transjordan, leaving it to the British who merged it with Palestine. Sir Herbert Samuel, the first High Commissioner for Palestine, established in Transjordan local councils of Arab leaders who maintained order and an administration under the guidance of several British army officers. Late in 1920 Abdullah, another of Husein's sons appeared at Ma'an in southern Transjordan with an armed force, ostensibly on his way to Damascus to regain the city for his brother. Because Abdullah was cordially welcomed by the Arabs, Winston Churchill, then British Secretary of State for the Colonies, on his visit to Jerusalem in 1921, effected a compromise by recognizing Abdullah as Emir of Transjordan. The Emir agreed to accept advisers (Col. T. E. Lawrence was the first to hold this post) and a British subsidy for the maintenance of an Arab army. The Council of the League of Nations consented to this arrangement with the proviso that the articles in the Mandate of Palestine concerning the Jewish National Home were not to apply to Transjordan. In April 1923, Sir Herbert Samuel visited Amman and agreed to recognize the independence of the government whenever a constitution

SCOFIELD FROM EWING GALLOWAY

*The ruins of Gerasa of the Decapolis, a confederacy of ancient cities lying east of the Jordan which united in Roman times to form a customs union and to guard against invasion*

should be adopted that would respect the obligations to the British government. At that time Emir Abdullah organized his government around a self-appointed Council of Ministers. As the revenue of the government was inadequate to meet the expenses, Great Britain at first subsidized Abdullah to the extent of about £200,000 a year.

Transjordan was invaded from the east in 1922 and again in 1924 by the Wahabi Arabs. Serious fighting occurred, but in each case the British forces and Abdullah's Arab Legion, with the use of superior mechanized equipment, were able to rout the Wahabis. At that time a British air force camp was established at Amman and an air field at Ziza, south of Amman. In 1925, the Hadda Agreement defined the frontier to satisfy Abdullah and Ibn Saud, king of the Wahabis, and each agreed to punish perpetrators of raids into the other's territory. With peace insured, Transjordan was able to carry out a program of road improvement, water supply, and many long-needed developments. In 1931 the Hadda Agreement, which had also established a common frontier between Transjordan and Iraq, was supplemented by the Treaty of Friendship between these two states, and the long series of treaties which ended in the formation of the Arab League was begun.

Under High Commissioner Field Marshal Lord Plumer (1925-1928), the defense force in Transjordan was transformed into the Transjordan Frontier Force, which in turn became embodied in the British Imperial Army. In 1925-1926, while the risings in Syria were in process, the Frontier Force and an armored car contingent held the Transjordan frontier inviolable, although many Syrian exiles were admitted, appreciably increasing Transjordan's population. Under Lord Plumer, Transjordan experienced a period of economic development, internal security, fiscal reform, and general administrative co-ordination.

In Jerusalem, in February 1928, the British and Abdullah signed an Anglo-Transjordan treaty which, in effect, changed Transjordan from a mandate to a protectorate. Abdullah agreed that all communications with foreign powers would be directed through the British resident in Amman and that no foreigner would be appointed to any office without the approval of the British. Although the treaty stipulated that powers of legislation and administration were to be exercised by Abdullah through a constitutional government, the British High Commissioner was designated as Abdullah's guide in all matters with respect to finance, justice, foreign relations, tariffs, loans, construction and operation of railroads, budget, concessions for exploiting natural resources, and any law concerning matters governed by the mandate or the treaty. Furthermore, Abdullah consented to the maintenance of British armed forces in Transjordan and pledged his full co-operation with them.

Simultaneously with this treaty of 1928, Great Britain presented to Abdullah a constitution or organic statute for his issuance. Strong opposition arose among the people of Transjordan over this constitution and the treaty with Great Britain, but they were accepted in April 1929. The organic statute provides for an hereditary emirate in the family of Abdullah, to rule with the aid of an appointed Council of Ministers and an elected Legislative Council. All powers of the emir must be exercised through a written instruction or decree. The first Legislative Council was reluctant to pass any legislation, and Abdullah dissolved it when it refused to pass the budget. The principal governmental responsibility has been the maintenance of public security. For this task, the Arab Legion has been concerned with internal questions while the Frontier Force has defended the borderlands facing Syria, Iraq, and Saudi Arabia. Other functions of government have been the development of better motor roads to make all parts of the country more accessible, the establishment of an educational system, the introduction of vaccination, the founding of a hospital at Amman, and the improvement of agriculture. Many of the officials in the several departments of the government are Palestinians, Syrians, Lebanese, Iraqis, Egyptians, and Turks; Jordonian officialdom is a welter of nationality.

**World War II.** Upon the outbreak of World War II, the British took various precautionary measures to insure the position of Transjordan, and the Arab Legion and Frontier Force were strengthened and modernized. These forces played an extremely significant role in defeating the pro-Nazi attempted *coup* in Iraq in 1941, and in many ways the forces in Transjordan served as a shock force and as a steadying influence upon the entire Near East during World War II. Abdullah remained steadfast in his loyalty to Great Britain, perhaps in the hope of becoming the head of a larger or expanded Arab state.

**The Arab League.** In 1944 Transjordan was one of the signatories of the Alexandria Protocol which created the Arab League consisting of independent Arab states bound together to preserve Arab countries, including Palestine, for the Arabs. Although Abdullah visited Syria and Turkey in the interests of the Arab League, at times he wavered in his opposition to the Zionists and the partition of Palestine. He sold land in Transjordan to Zionist groups and unquestionably hoped to annex the Arab parts of a divided Palestine to Transjordan. In 1946 Abdullah negotiated another Anglo-Transjordan Treaty, grainting him greater independence and obtaining British recognition of his position as King of Hashimite Transjordan.

The treaty was revised in March 1948, making Transjordan a military ally of Great Britain and extending an annual British military subsidy of about £1,600,000. As a result, the Transjordan government obtained a stronger voice in the determination of facilities to be granted British forces

on Transjordan soil. On Oct. 20, 1947, the first elections for members to a House of Delegates, twenty in number, previously appointed by Abdullah, were held. Ten sheiks, appointed as before by the king, formed the House of Notables.

Transjordan was an important member of the Arab League, and King Abdullah, at first, pursued a policy in harmony with the general policy of the League. He backed its policy against the partition of Palestine, which he considered the most important concern of the whole area. In the meantime, Abdullah urged his plan for unifying Transjordan, Lebanon, Syria, and Palestine into a Greater Syria. This plan, together with the failure of Transjordan's famed Arab Legion to pursue an aggressive military role in the civil war in Palestine, antagonized all of the other Arab League governments. In December 1948 Abdullah was proclaimed King of all Palestine, Parliament approved the merger of Transjordan with Arab Palestine, the name of the new state became the Hashimite Kingdom of Jordan, and Abdullah appointed a new Mufti of Jerusalem.

Most of the other Arab states did not accept Abdullah's unilateral action and recognized the Arab government for Palestine in Gaza. Great Britain, however, continued its friendly relations and increased the financial aid to Abdullah. 1950 elections were held for a new Parliament, and a new House of Notables was appointed. The new Parliament approved of the formation of the Hashimite Kingdom of Jordan, and Abdullah notified the United Nations of the annexation. This action intensified the resentment of the dissident Arab elements, and on July 20, 1951, Abdullah was assassinated in Jerusalem by a supporter of the exiled Mufti who opposed the annexation of Arab Palestine. Abdullah was succeeded by his son Talal, who was in Switzerland suffering from a nervous disorder. In August 1952 Parliament removed Talal because of continuing ill health and proclaimed his son Husein as king.

Jordan has attempted to carry out a rather difficult and seemingly contradictory foreign policy. In 1951 it signed friendship pacts with Syria and Lebanon, and in 1952 it became a signatory of the defense pact of the Arab League. Its abandonment in 1952, under King Talal, of Abdullah's Greater Syria project improved relations with its Arab neighbors. In 1953-1954 border clashes with Israel threatened a renewal of the Israeli-Arab War, and in view of this, Jordan requested and received promises of military support from the Arab states. But at the same time it was sympathetic to the Western powers, possibly due to British influence, and expressed an interest in the Turkey-Iraq agreement. In 1955 Jordan was invited to join the Mid-East Defense Pact, sponsored by Turkey and Iraq (and later joined by Iran) but opposed by other Arab League members, Egypt and Saudi Arabia.

S. N. F.

**TRANSLOCATION IN PLANTS.** *See* PLANTS, TRANSLOCATION IN.

**TRANSMIGRATION.** *See* METEMPSYCHOSIS.

**TRANSMISSION LINES, ELECTRIC,** either wires strung on poles or towers, or underground cables. On the overhead transmission lines, the principal insulation is the atmosphere, supplemented by porcelain insulators to support the wires from the pole or towers. Because of the low dielectric strength of air, wires of opposite phase must be several feet apart. The conductors of opposite phase in underground cables, on the other hand, have to be very close together, necessitating the use of insulating material of the highest electric strength. The most suitable material for this purpose has been found to be kraft paper impregnated with mineral oil. Underground cables of this type are in operation for voltages as high as those for any aerial transmission line, namely, 230,000 volts. Serious problems arise in connection with the termination of underground cables because their ends are necessarily in air and require the wide separation characteristic of aerial lines. In order to bring the impregnated-paper-insulated conductors of an underground cable from their close proximity to the separation they require in air, elaborate terminal devices have to be installed. A similar problem exists where the widely separated conductors of an aerial line are brought into the confined space of a transformer. The difficulty of design of suitable terminals and the limitations imposed by corona, described at the end of this article, are the principal obstacles which have to be overcome as transmission lines are built for higher and higher voltages.

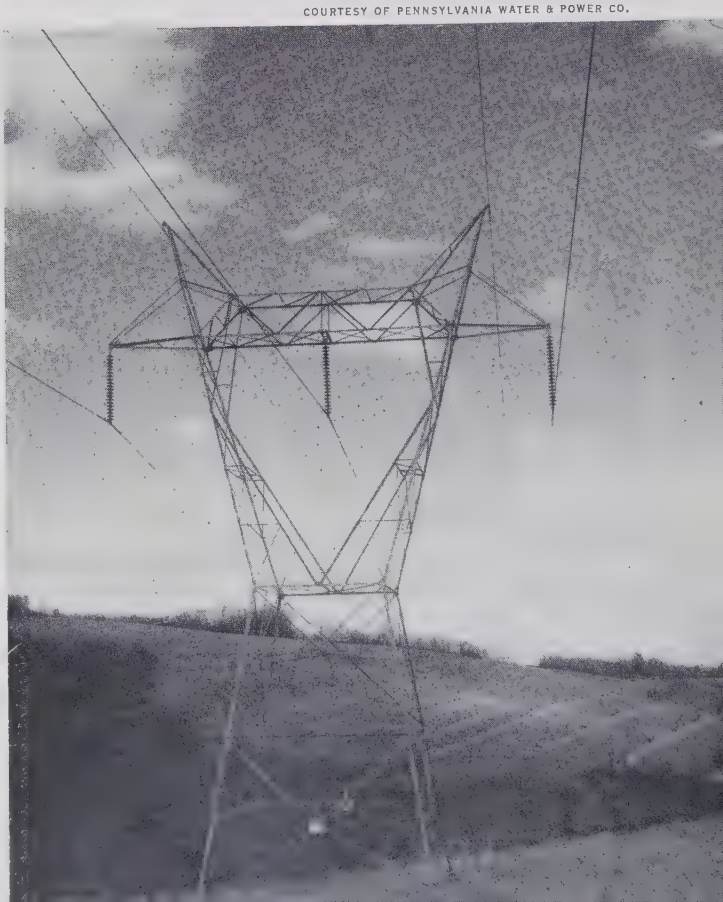
### POLE AND TOWER LINES

Pole and tower lines are used in electrical transmission and distribution as supports for conductor-carrying insulators.

**Poles.** Poles, usually of wood, are used for urban and suburban distribution, with an average spacing of about 125 ft. Since the disappearance of chestnut, the woods most favored are northern white cedar, western red cedar, creosoted pine, and wallaba. The crossarms, however, are more generally made of Dougas fir. Poles are set in soil to a depth varying from 5 ft. for a 20-ft. pole to 9 ft. for an 80-ft. pole, or about two-thirds these amounts if set in rock. Poles are guyed with galvanized steel wire where there is tendency for excessive bending, as at curves and ends of the line. Insulators are placed in the guy lines as a safety precaution. Crossarms are attached by one or two steel bolts after "gaining" the pole, i.e. cutting a flat surface against which the crossarm fits. Braces applied diagonally are used where the

*Typical tower and electric transmission lines carrying 220,000 volts*

COURTESY OF PENNSYLVANIA WATER & POWER CO.



load is heavy. The top surface of a crossarm is curved to shed rain. All hardware is of hot-dip galvanized steel.

**Towers.** Towers are made of structural steel, mostly angles, the four legs being either set in concrete foundations or bolted to structural-steel foundations. The spread (area) of a tower is usually about 20 to 25 per cent of its height. Flexible two-leg towers are also in limited use. Crossarms of towers are of steel, integral with the main structure.

**Insulators.** There are two types of insulators. One type is supported on the crossarm on either wood or steel pins, wood being used only up to 7,500 volts. Wooden pins fit in holes in the crossarms and are nailed in place. Steel pins have a threaded shank which passes through a hole in the cross-arm, and they are fastened by a nut and lock washer underneath. Such insulators are used up to about 25,000 volts. Above this voltage, another type of insulator, known as the disk or suspension type, is used, consisting of a series of disks, usually of porcelain. These hang below the crossarm and are connected together by hardware which gives flexibility to the string and is so attached to the disks as to put the porcelain in compression.

**Cables.** The cables used on pole and tower lines are generally either of bare copper or bare aluminum with a steel core. Cables hang in a catenary curve which is so nearly a parabola that design calculations are usually based on the simpler equations of a parabola. These equations give the relation between span, sag, tension, weight of cable, temperature, and weight of ice and wind loads.

**Zones and Hazards.** The National Electric Safety Code divides the United States into three ice and wind zones for purposes of aerial line design.

Overhead lines are subject to vibration, revealed by humming, which is likely to cause breakage of the wire at, or near, the insulators. Vibration may be stopped by means of a Stockbridge damper, a dumbbell-shaped metal weight attached to the cable at the center of its waist. When coated with ice, overhead lines are also subject to "dancing," an irregular motion of considerable amplitude, if there is gusty wind. Such dancing has been known to wreck a line completely, and there is no known way to stop it except by melting off the ice. Lightning protection is afforded by arresters and choke coils at the stations, by arresters at intervals along the line, or, in the case of the higher voltages, by one or more grounded cables carried at the top of the towers, above the transmission cables.

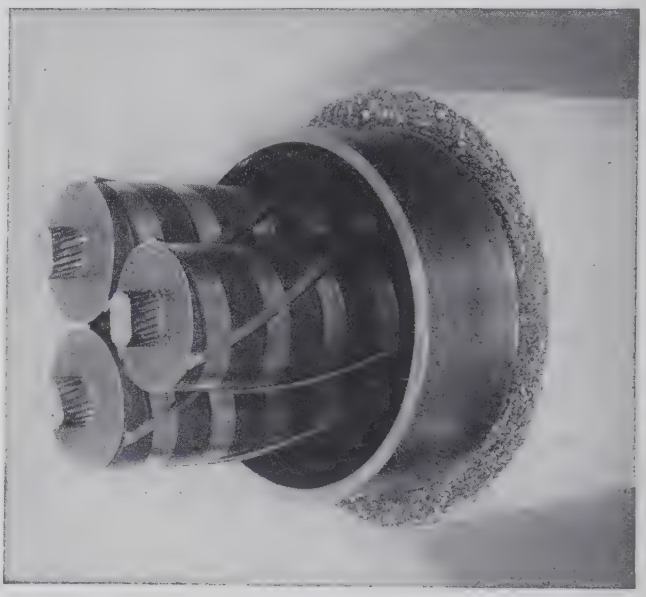
## HIGH-VOLTAGE CABLES

Practically all high-voltage cables are used for three-phase circuits and therefore are either three-conductor cables or single-conductor cables used in groups of three.

For voltages of about 15,000, rubber insulation is used only for such special purposes as submarine cables, and a few aerial distribution lines. Varnished-cambric insulation is used for high voltages to a limited extent, principally for station cables and in places where there are tall vertical runs. Such cables are insulated with helically-applied tapes of varnished cambric with a "slipper" of oil or grease between layers.

**"Solid" Impregnated-paper Cables.** Impregnated paper in several forms is almost universally used for important high-voltage cables for several reasons, among which are economy, higher dielectric strength, lower energy loss in the dielectric, and excellence of service record. The basic element of a paper-insulated cable is a stranded copper conductor covered with strips of oil-impregnated kraft paper, about ¾ in. wide and about 0.006 in. thick. The paper is laid helically with about 1/32 in. between turns, successive layers being staggered about one-third the tape width and the number of tapes depending on the voltage. In a single-conductor cable, this basic element is enclosed in a lead sheath. In a multiple-conductor cable, a group of such "singles" is laid up helically, and the group, usually rounded out with crepe-paper fillers, is enclosed in a lead sheath.

For three-conductor cables up to about 10,000 volts it is usual to place a belt of paper insulation over the group of singles and fillers. Formerly, this construction was used up to about 33,000 volts but was abandoned in the higher ranges



COURTESY OF PHELPS DODGE COPPER PRODUCTS CO.

*Three-phase, 138,000-volt, compression cable system. Steel pipe contains oil or nitrogen under a pressure of 200 lb. per sq. in. The cable is insulated with oil-impregnated paper, sheathed with polyethylene, and armored with bronze tape. The segmental wires over the bronze tape are "skid wires" to facilitate installation.*

because of a destructive phenomenon due to the nonuniformity of the voltage at the surface of the singles around the circumference. This condition gives rise to tangential stresses, that is, electrical stresses along the surface film of oil on the paper. Since the oil has only a small fraction of the dielectric strength of the impregnated paper, it chars, with resultant serious damage to the cable.

**Shielding.** Tangential stresses were overcome by the device of shielding. First introduced in Germany by Martin Hochstadter about 1913, shielding consisted in enclosing each insulated conductor in a shield composed either of metal or metallized paper, whereby the voltages all around the circumference of the insulation were equalized. Shielding also had the effect of preventing ionization of any voids that might exist between the insulation and sheath. Such voids were liable to occur because the expansion of the oil under load would stretch the sheath beyond its inherent elastic limit, leaving spaces as the oil contracts with decreasing load. In the United States, this system came into general use in the 1920's. Shielding has become standard practice on all three-conductor cables for over 15,000 volts; many utilities place the limit at about 10,000 volts.

The success of external shielding prompted inventors, notably C. Beaver in England and M. Weiset in Germany, to use internal shielding, i.e., shielding over the conductors. This may take the form either of paper coated with aluminum or paper containing sufficient carbon black to make it

semiconducting. In either case, both the 60-cycle and impulse dielectric strength are somewhat augmented. Shielding did not entirely eliminate ionization of voids, and as transmission voltages increased it became necessary to have cables without ionizable voids.

Cables so far discussed have been of the type known as "solid" because the insulation is handled as if it were a solid like rubber. During manufacture, such cables are dried and impregnated with viscous mineral oil, sometimes holding rosin in solution, just before the application of the lead sheath. Solid cables are made in lengths averaging about 400 ft. and are shipped on wooden reels. In American practice, they are installed in ducts, the ends terminating in manholes, where joints are made between successive lengths. European and South American cables are generally armored with steel tape and are buried directly in the ground or in concrete troughs. The joints between successive lengths are also buried.

**Fluid-filled Cable System.** J. F. Watson of England proposed in 1914 to use a thin (low-viscosity) oil which would move with comparative freedom through the paper insulation and quite freely through special tubular channels built into the cable and connected to reservoirs at the joints. By this means, expansion and contraction of the oil would be directed into and out of the reservoirs without stretching of the lead sheath or forming voids. It remained, however, for L. Emanueli of Italy to develop this idea into a practical combined electrical and hydraulic system, known as the fluid-filled or oil-filled cable system. In this, the oil channel consists of a tube of helically laid steel or bronze strip. In single-conductor cables, the strip is located inside the conductor; in three-conductor cables, in each of the three spaces ordinarily occupied by fillers. This system has had an enviable record of success on a large scale, especially for voltages from 33,000 to 138,000. One line in Paris, France, operates at 230,000 volts. The line of cable has to be designed on a hydraulic basis to balance or limit the internal pressure on grades and with respect to the flow of oil in and out of the reservoirs, through the long, narrow oil ducts. To facilitate this balancing, stop joints are used at intervals along the line and reservoirs are installed at each such joint, thus limiting the distance that the expanding and contracting oil has to travel. These reservoirs are tanks containing multiple pressure-responsive metal cells which hold either the oil, itself, or nitrogen gas under pressure, in which case the oil is in the tank external to the cells. Where it is not possible to balance pressures by gravity, nitrogen gas pressure in the tank may be substituted.

**Pressure Cables.** In the middle 1920's, H. W. Fisher and R. W. Atkinson conceived the idea of putting cable insulation under gas pressure so as to eliminate voids. The system was never implemented in any practical form. The idea, however, was taken up by Martin Hochstadter and W. Vogel of Germany soon after the appearance of Emanueli's fluid-filled cable system. Whereas in the Emanueli system it is customary to install the cables in ducts, these inventors developed a system known as the compression cable system, wherein the cable is of the solid type with a lead sheath but is contained in a steel pipe under a gas pressure of some 200 lb. per square inch. Such a pressure squeezes the lead sheath against the insulation and develops a substantially-equal pressure inside the cable so that void formation and ionization are effectively prevented.

In all the numerous European installations of the compression cable, and in the first American installation in Detroit, the cables have lead sheaths and the pressure medium in the pipe is nitrogen gas, pressure being applied from high-pressure gas cylinders, through reducing valves, at the ends of the line. Later American installations have a sheath of polyethylene reinforced with bronze tapes instead of the lead sheath, and sometimes oil is used as the pressure medium. In such cases, pressure is applied by means of small pumps at the ends of the line, and the expansion and contraction of the oil are taken up by terminal tanks.

In American practice the pipe is seamless steel, with welded joints every 40 ft. and corrosion protection of the highest quality. Some installations have been made in England wherein the cable has a double sheath with a gas pressure space between them, the outer sheath being heavily reinforced with metal tapes to withstand the gas pressure.

**Oilostatic Cable.** In the early 1930's Hugo Sonnenfeld of Czechoslovakia and C. E. Bennett at Hawthorne, N. J., independently developed a form of pipe pressure cable differing from Hochstadter's in having no permanent cable sheaths. The cable, which is of the solid type, is made with a sheath provided with a rip-wire by means of which it is removed as the cables are drawn into the pipe. The oil pressure is maintained, and the oil expansion and contraction are provided for by terminal pumps and reservoirs. Several successful lines of this Oilostatic system are in operation at voltages up to 132,000, one of the most notable being that of the Pennsylvania Railroad at Baltimore.

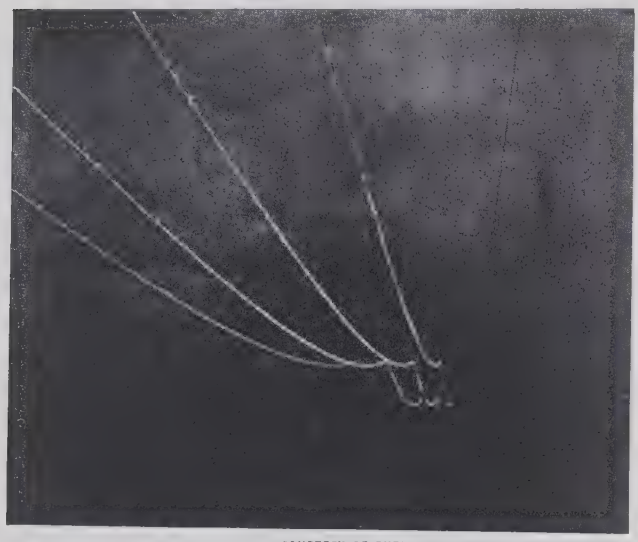
**Low- and Medium-pressure Gas-filled Cable.** An ingenious type of cable for voltages up to about 46,000, developed by G. B. Shanklin, came into use in 1938. In the past, every effort had been toward preventing the formation of voids in paper cables, whereas this inventor deliberately drained as much oil as possible and replaced it with nitrogen gas. The cable is kept under a pressure of 15 to 20 lb. per square inch from tanks at the terminals, using channels, similar to those in fluid-filled cables, as a means for applying the pressure to the insulation. In a three-conductor cable, two of these channels are made of helical bronze tape and therefore allow the gas access to the insulation along their entire length. The third gas channel is a solid copper pipe, open only at the joints, serving to by-pass any obstructions in the other channels which might be caused by oil slugs. Single-conductor cables have gas ducts in or under the sheath for local gas pressure, and usually use an external pipe, connected into the joints, to carry the gas pressure past local obstructions. The moderate pressures used in these cables is not great enough to bulge the sheath. Cables of similar type have been developed for gas pressures of 40 lb. per square inch. In these, an extra-thick sheath or one with suitable reinforcement is used.

Cables with minimum excess oil but no sheath, placed in steel pipe with nitrogen gas under pressure, are in use in England and there is one installation in Detroit, where it is known as the S.M.D. system. The latest development in pressure cables is the Hydrolene system, invented by K. S. Wyatt, in which the cable is insulated with polyethylene, the pressure medium is water, the pressure is 50 to 100 lb. per square inch, and the pipe is normally of asbestos cement. It is important that in these various pressure systems, all the conductors of a circuit, usually three, be placed in one pipe to avoid having magnetic material between phases, thus preventing the formation of eddy currents and consequent loss of power.

## CORONA

Corona is a luminous glow which appears on an electrical conductor when the electric stress near its surface becomes greater than the dielectric strength of the surrounding air. This phenomenon, unless proper precautions are taken, may

occur on high-voltage transmission lines, giving rise to considerable loss of energy and radio interference. Corona is explained by the ejection of ionized (charged) particles from the high-voltage conductor and their collision with molecules of the gases composing the surrounding air. Such collisions ionize the gas molecules and lead to the formation of more ionized particles, the action extending outward until a distance is reached at which the electric-field strength is insufficient to support it. Ionization by collision cannot occur unless



COURTESY OF PHELPS DODGE COPPER PRODUCTS CO.

*The phenomenon of "corona" on an electric power line*

the ionizing particles are moving at a sufficient velocity to detach ions, i.e., charged particles, from the molecules of air. Therefore, the dielectric strength of air is critical not at the surface of the wire but at a distance sufficient to allow the ejected ions to accelerate to the requisite velocity. It is usual to design transmission lines to operate without corona, using formulas originated by F. W. Peek and modified by others. However, on lines far from inhabited communities, it may be permissible to operate with mild corona, both as an economic measure, where the incremental cost of power is low, and to serve as an aviation warning. Corona may be eliminated or reduced by making the conductor diameter great enough to keep the electric stress below the ionization point of air.

The voltage at which corona appears depends on a number of factors: (1) whether the wire is solid or stranded—corona is higher with solid than with stranded conductors; (2) the number of wires in the outer layer of a stranded cable (the outer layer usually has 6 or 12 wires)—the smaller the number of wires, the higher the corona; (3) the spacing of conductors—the greater the spacing, the higher the corona; (4) the smoothness of the surface—the smoother the surface, the higher the corona; (5) the presence of grease on the wires—the less the amount of grease, the higher the corona; (6) the barometric pressure—the greater the pressure, the higher the corona; and (7) the temperature—the lower the temperature, the higher the corona.

Conductors of ordinary stranded construction, used for very high voltages, would require a greater amount of metal than needed to carry the current if they were to have the requisite diameter for corona suppression. It is economical, therefore, to use conductors of special design, such as the following: (1) the A.C.S.R. type, consisting of aluminum wires stranded over a steel cable; (2) the H.H. or Hedderheimer type, consisting of a tube of interlocked strips of copper; (3) the P.D.C.P. type, consisting of one or more layers of copper wires stranded over a group of hollow copper tubes; or (4) the I-beam type, consisting of one or more layers of copper wires laid helically over a twisted copper I-beam. *See also* ELECTRIC-POWER TRANSMISSION; VESSELS, INLAND. W. A. Del M.

**TRANSPIRATION IN PLANTS.** *See* PLANTS, TRANSPIRATION IN.

**TRANSPORTATION.** *See* AIR TRANSPORT; AVIATION, HISTORY OF; AVIATION INDUSTRY; FREIGHT FORWARDER; HIGHWAY ENGINEERING; MERCHANT MARINE; MOTOR TRANSPORT; PETROLEUM (*Pipe Lines*); PRIMITIVE CULTURE (*Primitive Industry*); RAILROADS; WATER TRANSPORT.

**TRANSPOSING INSTRUMENT,** a musical instrument that produces notes of a different pitch from those written for it. A large number of the wind instruments, in particular the clarinets, trumpets, horns, and saxophones, are of this type. Originally these instruments were constructed in a variety of sizes, to produce various key and pitch ranges. To obviate the need for the player to learn new fingerings or positions for each real sound to be produced, the convention developed that the fundamental tone would be designated as "C," whatever the actual pitch of the instrument might be. Thus the note "C," if played on a trumpet in B♭, produces the sound of B♭, and each note played on such a trumpet sounds correspondingly one tone lower. On the same principle, the "C" of a horn in F actually sounds as F, with all real sounds a fifth lower than those written. The string bass and contra bassoon are transposing instruments whose notes sound one octave lower than written, while the piccolo in C sounds notes an octave higher. In these cases the transposition is made to eliminate the excessive and confusing use of ledger lines in the written parts. *See also* CLARINET; HORN; SAXOPHONE; TRUMPET. R. F. G.

**TRANSPOSITION,** in music, the rewriting or extemporaneous performance of a passage in another key, and thus another pitch, than that in which it originally appears. Rewritten transposition is often necessitated by the inability of singers to reach the extreme notes of a song or aria, while transposition "at sight" is a common necessity among modern orchestral players confronted with parts written for an instrument pitched differently from their own; many clarinetists, for example, play parts for the obsolete C clarinet on a B-flat instrument, thus mentally transposing every note a tone higher. *See* TRANSPOSING INSTRUMENT. W. Li.

**TRANSUBSTANTIATION,** the technical term employed by the Roman Catholic Church to express the total substantial conversion of bread and wine into the body and blood of Christ in the celebration of the Holy Eucharist. A conversion is a change of one thing into another in some aspect of being, and implies two positive extremes. A change is substantial when one substance becomes another, and if this conversion affects the whole substance and results in the transition of the entire substance of one thing into the substance of another thing, it is said to be total. Hence the doctrine of transubstantiation comprises three distinct propositions: 1) that though the accidents of bread and wine continue, their respective substances no longer exist; 2) that Christ is really present under the appearances of bread and wine; 3) that these two doctrines result from the total conversion of the bread and wine into the body and blood of Christ. Such change is without parallel in nature, and is

appropriately named since transubstantiation accurately describes this unique conversion. Thus excluding consubstantiation, which means that in the Holy Eucharist bread and wine persist and that the body and blood of Christ coexist in and with the natural elements, and excluding impanation, which proposes a personal union between bread and wine and the God-Man, transubstantiation represents precisely the Catholic teaching, and furnishes Catholics with a sure criterion for discerning errors relative to the Holy Eucharist. It is the teaching of the Church that this total conversion is clearly set forth in Christ's words: "this is my body;" "this is my blood." When He who is All Truth and All Power said these words, through their utterance the bread became the body of Christ and the wine became His blood. And to the priests of His Church He gave the power to do as He had done. D. J. M. C.

**TRANSVAAL** [transvɑ'l], an inland province in the northeastern part of the Union of South Africa. It is bounded on the north by Southern Rhodesia, on the east by Mozambique and Swaziland, on the south by Natal and the Orange Free State, and on the west by the Cape of Good Hope and Bechuanaland. The Limpopo River forms the northern boundary, and the Vaal and Pondola the southern. The area of the Transvaal is 110,450 sq. mi.

**Geographical Features.** In the southern part of the Transvaal are the treeless plains and rolling grass country of the High Veld, most of which is about 5,000 ft. above sea level. The eastern section of the High Veld is traversed by the Drakensberg Mountains, whose ragged outliers extend northward almost to the Limpopo. To the east of these ranges the land falls away to less than 1,000 ft. along the Mozambique border. To the north of the High Veld is the Bush Veld. Here both altitude and precipitation decline toward the north. The Transvaal as a whole is within the region of summer rainfall, more than 85 per cent of the precipitation coming between October and March. Rainfall exceeds 50 in. annually in the Drakensbergs and is below 15 in. in the far north. Throughout most of the High Veld it is between 25 and 35 in., decreasing toward the west and north. At Johannesburg (5,735 ft. above sea level) the average annual rainfall is 29.47 in.; the annual maximum temperature is 70.7° F., and the minimum is 47.9° F. Much of the province's precipitation is in sudden thunderstorms, and much of it is lost in runoff. Although there is much heavy scrub country, there are only a few small forested areas. With the advance of settlement, wild life has become scarce except in game reserves, notably the Kruger National Park (area about 8,000 sq. mi.) located between the Drakensbergs and Mozambique.

**Population.** The Transvaal had a 1951 population of 4,801,708, thus making it the most populous of the Union's four provinces. Population by groups was as follows: native Africans, 3,472,640; Europeans, 1,205,458; colored or mixed, 75,415; and Asians, 48,195. The majority of Europeans live within a radius of about 40 mi. of the industrial and mining center of Johannesburg, which in 1951 had a total population of 629,847, of whom about half were Europeans. Johannesburg is the largest city in southern Africa. Pretoria, capital of the province and administrative capital of the Union, had 230,243 inhabitants in 1951. Other important cities are Germiston (114,215) and Krugersdorp (74,960), both within 20 mi. of Johannesburg.

**Government.** The government of the Transvaal is derived from the South Africa Act (1909) and subsequent amendments to it. According to the Senate Act of 1955, the Transvaal is represented in the Senate of the Union by 27 seats. The Transvaal's representation in the Union's 159-member House of Assembly is based on population. At the 1953 election Transvaal obtained 68 Assembly seats. Under the Union's Bantu Authorities Act of 1951, the Transvaal African population is largely administered through tribal, regional, and territorial structures, established in accordance with traditional institutions.

*SWIRLING WATERS OF THE NELS RIVER NEAR NELSPRUIT STATION IN EASTERN TRANSVAAL*

COURTESY OF THE UNION OF SOUTH AFRICA GOVERNMENT INFORMATION OFFICE

As in the other provinces, the Transvaal's executive branch has an administrator appointed by the governor-general in council, and a provisional council, elected for five years, which has an executive committee of four. There are 66 members in the provincial council, and their governmental authority extends to local matters. Ordinances passed by the provincial council are, however, subject to veto by the governor general in council.

**Economic Activities.** Industry, mining, and agriculture (including pastoral pursuits) in that order are the basis of

the Transvaal's economy. The rapidly developing industry of the province ranges from the manufacture of iron and steel at Pretoria and Vereeniging to the small plants for processing agricultural produce located in other cities. There are engineering factories of various kinds, brass foundries, chemical plants, grain mills, breweries, brick and tile works, potteries, auto-assembly plants, and other industrial establishments. About half of the world's supply of gold comes from the Transvaal's fabulous mines on the Witwatersrand on either side of Johannesburg. The province's 1953 gold production of 11,940,616 fine oz., most of it coming from the Rand, was valued at £147,564,998. Uranium mining is now associated with South Africa's gold-mining operations, and many of the Rand's mines have installed uranium recovery plants. The largest known white diamond—the Cullinan—was found just east of Pretoria in 1905. The province's 1953 diamond output was valued at £13,992,729. Other important mineral products are coal, copper, tin, iron, asbestos, limestone, chrome ore, nickel, lead, silver, and the platinum metals.

Only a small proportion of the 55.5 million acres suitable for farming is cultivated. Chief products are sorghum, maize, oats, wheat, tobacco, vegetables, and citrus fruits. Much of the fruit and about half of the tobacco are exported. Cattle and sheep are the most valuable livestock, with meat, wool, hides and skins the chief animal exports.

**Transportation.** The Transvaal has 3,399 mi. of railway owned and operated by the Union. Main lines cross the province from north to south and from east to west, and there is a network of branch lines limited largely to the High Veld country of the south. The Union of South Africa Railways also operates an extensive motor road service. Johannesburg is the Union's air transport center, both local and international, and the terminus of British, South African, Swiss, Dutch, and Belgian lines to Europe and of Pan American World Airways to New York.

**Education.** Education is compulsory for European children, and 92 per cent of them attend government schools. As the result of the Bantu Education Act, education of the Transvaal's African population comes under the jurisdiction of the Union's central government, a system that supplants a previous network of state-aided missionary and church schools. The province had 1,488 Bantu schools in 1954. There is a third school system for both colored and Asiatic children and some schools for Indian children only. Government support for non-European schools substantially increased during the 1940's. The University of Pretoria is for Europeans only, while the University of Witwatersrand admits non-Europeans. Potchefstroom University College is a branch of the University of South Africa.

**History.** Before the early nineteenth century the Transvaal was inhabited mainly by the Bantu natives. Then the Zulus (Matabele) invaded and conquered large parts of the territory. In 1829 Robert Moffat, famous missionary of Bechuanaland, visited the Transvaal, and British explorers and traders soon followed. After the Great Trek of the Boers (1835-1840) Dutch settlements were made despite battles between the Boers and Bantu natives. The Boers declared the Transvaal independent, and many who disliked the British rule found a refuge there.

By the terms of the Sand River Convention of 1852, Great Britain acknowledged the independence of the Transvaal. In 1855 the town of Pretoria was founded. Marthinus Pretorius, first president of the South African Republic, as the Transvaal was called, wished the Orange Free State to join with the Transvaal to form a great Dutch-speaking republic. The Orange Free State declined and was not persuaded even when Pretorius and Paul (Oom Paul) Kruger led a raid to force the union of the two states.

The new South African Republic was soon divided by political rivalries and religious controversies. The machinery of government was almost paralyzed, and the economically weak state was nearly bankrupt. In 1877 Sir Theophilus Shepstone, British South African secretary for native affairs, annexed the Transvaal. The Boers proclaimed a republic again in 1880, went to war with the British, and obtained self-rule in 1881 under British sovereignty. The Transvaal then sought to expand, especially toward Swaziland, Zululand, and the coast; but the British and the natives resisted Boer encroachment. When gold was discovered in 1886 thousands of Uitlanders (foreigners) entered the Transvaal, particularly in the Witwatersrand area. The Boers took drastic measures to maintain their supremacy, and under Kruger continued a policy that was partly responsible for the Boer War (1899-1902). Four years after the end of the war the British government granted the colony self-government. In 1910 the Transvaal joined Cape Colony, the Orange Free State, and Natal to form the Union of South Africa, and the first prime minister of the new union was General Louis Botha, who had been premier of the Transvaal since 1907. Together, he and Jan Christian Smuts, also from the Transvaal, guided the affairs of the new Union for the next decade. W. M. W., G. S., and W. W. W.

**TRANSYLVANIA COLLEGE,** an accredited, coeducational, privately controlled college of arts and sciences, located in Lexington, Ky. It is under the auspices of the Disciples of Christ Church. The institution was chartered in 1780 and first instruction was offered in 1785. It was named Transylvania Seminary in 1783. In 1798 the name was changed to Transylvania University. After many changes in name and mergers with other educational organizations, the institution became known in 1915 as Transylvania College, although the legal name continues to be Transylvania University.

The only degree offered is the A.B. Pre-law, pre-medical, teacher, and business administration courses are given. Students not living at home must live in the college residences. Scholarship aid of small stipends is offered and there is a fund for loans. Some tuition scholarships are administered specifically for foreign students. Opportunities for self-help enable some students to earn part of their expenses. *For statistics see* COLLEGES AND UNIVERSITIES.

J. R. To.

**TRANSYLVANIAN ALPS,** a mountain range in Romania, crossing the country in an east-west direction. Actually the southern part of the great Carpathian arc, the Transylvanian Alps are so-called because they are reminiscent of the Swiss Alps in both appearance and development. Formed in Tertiary times, they are composed of a great crystalline core of gneiss, granite, and schist, with small zones of sedimentary rock on its flanks. Although cirques point to former glaciation, none of the present peaks are snow-capped permanently. The highest elevation is attained by Mt. Negoi, 8,347 ft. above sea level. Many low passes, some occupied by tributaries of the Danube River, allow easy railroad communication between the Danube Plain, south of the Alps, and the Transylvanian Basin, which is framed by the Alps and the Carpathians. D. L.

**TRAP,** a field and commercial term for any dark, fine-grained, igneous rock. The usual species included under this

name are basalt, diabase, and andesite. In trade parlance the coarser-grained gabbro and diorite may also be marketed as trap. The quarrying and crushing of trap is a fifteen to twenty million dollar industry annually in the United States. Leading states in trap production are Connecticut, New Jersey, Oregon, and Washington, with California, Colorado, New York, and Pennsylvania falling in the second group. Trap is used principally in concrete and road metal; other uses are as railroad ballast and riprap. K. K. L.

**TRAPANI** [trɑpɑ′ni], a province and also the capital city of the province, at the western extremity of Sicily. Trapani apparently took its name from the Greek word for sickle, *drepanon,* which the curving peninsula on which the city stands resembles.

**The City.** Trapani, 47 mi. west of Palermo, at 38° 1′ N. lat. and 12° 29′ E. long., is situated on a tongue of land which extends westward from the mainland for over two miles, terminating in several small islands and shoals. On the mainland, to the northeast, rises the massive height of Monte San Giuliano, which was famous in antiquity as Mount Eryx. To the south stretches a wide and fertile coastal plain. The important port of Trapani is on the southern side of the peninsula. Historically it was the port of departure for nearby Africa, and later was the entrepôt for traffic with the Egadi and other islands. Trapani is the terminus of two railway lines from Palermo. Salt, produced locally, is exported in large quantities, along with wine, fish, and prepared cereals. Enclosed within a wall, Trapani has been the scene of much conflict because of its strategic location at the tip of Sicily and at the narrowest point in the Mediterranean. In Carthaginian possession at the outbreak of the First Punic War, it fell under Roman rule in 241 B.C. The decline of Rome brought in the Vandals, who first touched Sicilian soil at Trapani. After a period of Byzantine rule, Trapani was conquered by the Arabs in the ninth century, who in turn were followed by the Normans in the eleventh century. In June 1266 a hard-fought naval battle took place off Trapani between Genoese and Venetian forces, with the latter triumphant. Pop. (off. est. 1947), 73,062 (including suburbs).

**The Province.** The province of Trapani comprises 20 communes, with an area of 965 sq. mi. In general, elevations are low, broken occasionally by peaks over 2,500 ft. Most of the population is engaged in agriculture, chiefly cereals, fruits, and wine. The principal industries are salt and wine production. The city of Marsala is noted for its own brand of fortified wine. Other important cities in the province are Alcamo, Castelvetrano, Erice, Mazara del Vallo, and Castellammare del Golfo. Pantelleria and the Egadi Islands belong to the province. Pop. (off. est. 1947), 412,000. R. G. W.

**TRAPASSI, PIETRO.** *See* METASTASIO.

**TRAP-DOOR SPIDER,** a common name given to various burrowing spiders, related to the tarantulas, that fit the top of their burrows with a hinged lid. These spiders live mostly in the warmer parts of the United States. They are much more abundant than is generally known, because of their nocturnal habits and well-concealed burrows. When disturbed, the spider holds the lid shut with surprising strength. The best known species are *Pachylomerides audouinii,* a 1⅓ in. spider, of the southeastern states and *Bothriocyrtum californicum,* a 1-in. spider, of southern California. The latter species can survive many months without food or water. Their food consists of insects which they capture at night. The young are hatched in the burrows. W. I.

**TRAP DRUM,** a colloquial term for the bass drum used in theatre or dance bands. It is played, together with a small cymbal, by means of a foot-pedal. Sounding the fundamental rhythm with this combination, the trap drummer has his hands free to manipulate countless auxiliary instruments and sound devices. Among these are snare drums, extra cymbals, wood blocks, *maracas* and other rattles, gongs, bird and animal calls, triangles, ratchets, bells, chimes, and whistles of many kinds. W. Li.

**TRAPEZIUM.** *See* GEOMETRY.
**TRAPEZOID.** *See* GEOMETRY.
**TRAPPING.** *See* HUNTING AND TRAPPING.

**TRAPPISTS** are the members of the Order of Cistercians of Strict Observance, a Roman Catholic religious order. The order was founded in 1098 by St. Robert de Molesmes in the Monastery of Cîteaux in France, and reformed in 1664 by Abbot Arman de Rancé of the Abbey of Notre Dame de La Trappe. In 1925 the revised Constitutions of the Order were approved by Pope Pius XI. The Order has about 3,000 professed members in some 80 monasteries throughout the world. The Abbot General of the Order resides in Rome.

The monks follow a strict and austere observance of the rule of St. Benedict, in a common life of prayer and seclusion. They support themselves by manual labor, especially agriculture and cattle raising, in which their skill has always been famous. Among them have been great saints and scholars. Introduced into the United States in 1848, the Trappists numbered in 1954 nearly 800 in six abbeys and three monasteries, of which two (Gethsemane in Kentucky and New Mellary in Iowa) date from 1848 and 1849 and six were founded since 1944. W. C.

**TRAPSHOOTING,** a test of shooting skill, generally with a shotgun, at aerial targets. The original targets were live pigeons, released or sprung from a cagelike affair known as a trap; from this the sport received its name.

**Origin and Development.** Pigeon shooting originated in England in the 1790's and first became popular in the United States in about 1830. A typical set of pigeon-shooting rules dating from the 1860's stated that single birds should be shot at a 21-yd. rise and double birds at an 18-yd. rise, the "rise" being the distance from the gunner to the traps. The butt of the shotgun had to be held below the gunner's elbow until the trap was sprung. A boundary fence was erected at a distance of 100 yd., and a bird, to be scored, had to fall within this boundary and be retrieved by hand within three minutes.

The first artificial targets used instead of live pigeons were glass balls which broke when hit. These were tossed into the air by a spring trap and shot at under rules and in a manner similar to pigeon shooting. The first such device was introduced in the United States in 1866. The glass ball did not prove a very satisfactory substitute for live pigeons and was soon supplanted by a target known as a clay pigeon, invented in 1880. This was a saucer-shaped target made of brittle clay, which, when sprung from the trap with a spinning motion, sailed for a considerable distance in the manner of a discus. Soon accepted as the most satisfactory artificial target for shotgun shooting, this clay pigeon has remained universally popular among trapshooters and has almost entirely replaced the use of live pigeons.

In modern trapshooting at clay pigeons, the gunner shoots in rotation from five stands, located directly behind and a little to each side of the trap to provide variety in the shoot-

ing angle. The distance from the shooting position to the trap is 16 yd. The gunner is scored on the number of hits he makes out of each 25 shots. Skeet shooting, conducted at closer range and at a greater variety of shooting angles, is an outgrowth of the so-called down-the-line style of trapshooting. The record run of hits in regulation trapshooting was set in 1938 by Joe Hiestand, who broke consecutively 1,179 officially judged targets without missing. D. Ho.

**TRASIMENO** [trɑ′zimɛ′no], the largest lake in peninsular Italy, having an area of 50 sq. mi., a perimeter of 33 mi., and a maximum depth of 20 ft. It is on the northwestern edge of Umbria, in the province of Perugia, and its surface is at an elevation of 850 ft. above sea level. Formerly it was believed to have been a Pliocene or post-Pliocene lake, similar to others in several Umbrian intermountain valleys. The present opinion is that it is of recent origin, formed by the filling up of its outlets. Its basin, especially for so large a lake, is very small. There are two small islands: Isola Maggiore, in the north, and Isola Polvese, in the southeast. Trasimeno has no natural outlet. An ancient artificial outlet, which had ceased to carry off the water, was replaced in 1898 by a ditch connecting it with the Nestore River, a tributary of the Tiber. Prior to this, the lower areas around the shores had been subject to periodic and disastrous inundations. A proposal to drain the remarkable shallow lake was dropped when the level of the lake became stabilized. Passignano is on the northern shore and Castiglione del Lago on the western. At Lake Trasimeno, Hannibal inflicted a severe defeat on the Roman army under Flaminius in 217 B.C.

R. G. W.

**TRAS-OS-MONTES E ALTO DOURO** [tra′zuzh mõ′ntzi ɑ′ltu tho′ru], the province in northeastern Portugal which includes the modern administrative districts of Vila Real and Bragança. The region has an area of 7,396 sq. mi. and is bounded on the west by the provinces of Douro Litoral and Minho, on the south and east by the Douro River, and on the north by Spain. Outlying flanks of the Cantabrian Mountains form part of the boundary to the north. The province is one of the least known sections of Portugal. The capital of the province is Vila Real.

Geographically, the major portion of the province is a slope of the great central Iberian plateau. It is granitic and calcareous, with vast sections supporting only enough vegetation to provide pasture for sheep. There are few trees, and villages are small, widely separated, and inhabited by primitive, pious, and conservative people. Tras-os-Montes is the coldest of Portugal's provinces; the climate is raw, and in the winter the temperature often falls below the freezing point. The Montezinho, although not extremely high, is Portugal's only mountain range covered with perpetual snow. The southern part of the province inclines towards the basin of the Douro and the Saber rivers; it has a better soil and in the more protected places has a type of agriculture similar to that usually found in Portugal. This southern verge, known for its port-wine grapes, also produces oranges, lemons, figs, olives, cork, and cereals. Capitals of the two districts of Vila Real and Bragança are the cities of the same names. Pop. 1950, 547,781. *See also* BRAGANÇA; BRAGANZA. J. S. R.

**TRAÙ** or **TROGIR** [trɑu′, tro′gɪr], a town on a little island in the Adriatic Sea, west of Split on the Dalmatian coast of Yugoslavia. As early as the fourth century B.C., a Greek town occupied the site. In Roman times it was called Tragurium. In medieval times it came under Venetian control. Its old bastions near the harbor gate, its fifteenth-century fortifications, its thirteenth-century cathedral, and other beautiful buildings give Traù a medieval aspect. Traù is connected to the mainland by a stone bridge. Pop. 1948, 23,468.

F. Sc.

**TRAUMATOTROPISM.** *See* TROPISMS.

**TRAUTMANN, REINHOLD** [trau′tmɑn] (1883- ), German linguist, was born at Königsberg on Jan. 16, 1883. He studied at the universities of Königsberg, Berlin, and Freiburg im Breisgau, took his doctor's degree at Königsberg in 1906, became *Privatdozent* for comparative linguistics at Göttingen in 1907, and in 1911 was appointed extraordinary professor of Indo-European linguistics and Slavic philology, and director of the Slavic Institute, at the German University at Prague. Thereafter he held professorships successively at Königsberg, Leipzig, and Jena and became a member of the Sächsische Akademie der Wissenschaften and of the Deutsche Akademie der Wissenschaften. For purposes of research he traveled extensively in Russia, Poland, Yugoslavia, and Italy.

Starting his scholarly career with research in comparative Indo-European linguistics and an intensive study of the Avesta, Professor Trautmann later turned more and more to Slavic linguistics, philology, and literature. Believing in a Balto-Slavic unity, he published a Balto-Slavic dictionary (1923). His interest in Slavic literature extends from the ancient Russian heroic lay, the ancient Russian chronicle of Nestor, and the Old Czech *Alexandreis* to such modern authors as Turgenev and Chekhov. He also contributed to the difficult field of proper names in his studies of Old Prussian personal names and Slavic place names.

Among Trautmann's most important publications are *Die altpreussischen Sprachdenkmäler* (1910), *Die altschechische "Alexandreis"* (1916); *Die altpreussischen Personennamen* (1925); *Der Wolfenbütteler niedersorbische Psalter* (1928); a translation of *Die altrussische Nestorchronik* (1931); *Volksdichtung der Grossrussen; Das Heldenlied* (1935); *Zu Form und Gehalt der Novellen Turgenjews* (1942); *Die slawischen Völker und Sprachen* (1947); and *Die Elb- und Ostseeslawischen Ortsnamen* (1949). F. M.

**TRAVAILLEURS DE LA MER, LES** [lɛ tra′vai′yœ′r də la mɛ′r] (*The Toilers of the Sea*), a novel of adventure by Victor Hugo, published in 1866 during the period of the author's exile on Guernsey in the Channel Islands, where the scene of the story is laid. The theme as announced in Hugo's preface is the conflict of man with the forces of nature, and the chief merit of the work lies in the magnificent descriptions of the sea. The hero, Gilliat, by his energy, resourcefulness, and bravery, vanquishes the elements, overcomes a vicious octopus in the most famous scene of the book, retrieves the engine from the wrecked ship *Durande,* and returns for his reward, marriage to Déruchette. Upon learning that the rector of the parish has won Déruchette's affection during his absence, Gilliat drowns himself in despair.

The novel contains many of Hugo's characteristic literary effects: personification of natural objects, astonishing coincidences, frequent antitheses, extensive use of unusual words, elaborate similes and metaphors, and long digressions on technical details. R. A. P.

**TRAVANCORE AND COCHIN, THE UNITED STATE OF** [træ′vənkor ko′tshɪn; kɒ′tshɪn], a state of India, formed in 1949 by the union of the two states of Travancore and Cochin and incorporated in the republic on the

inauguration of the new constitution of India in January 1950. Since both Travancore and Cochin have long and distinguished histories as distinct political entities, each will be considered separately. Pop. 1951, 9,280,425.

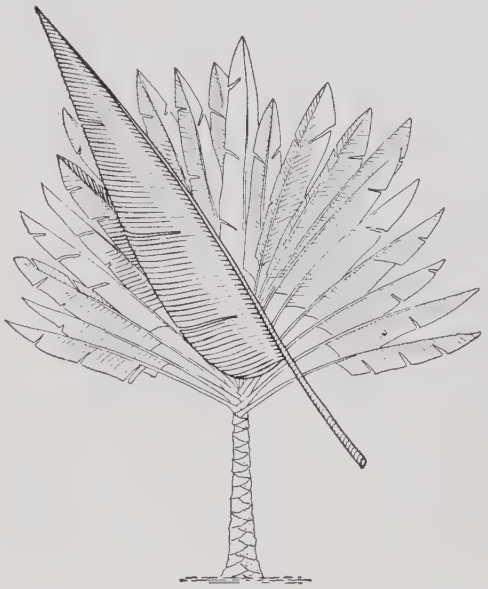
**Travancore.** Travancore, with an area of 7,662 sq. mi., lies at the southwestern tip of the Indian subcontinent. It is bounded on the north by Cochin and by the Coimbatore district of Madras, on the east by the Madura, Ramnad, and Tinnevelly districts of Madras, and on the south and west by the sea. Its rulers trace their descent from ancient Chera kings; the throne is inherited through the female line. For at least a generation the state has enjoyed a reputation as an enlightened despotism, outstanding for its high literacy rate of 47.05 per cent. Of the population, about two thirds are Hindu, and over one quarter are Christians. The Christian community of the Syrian rite traces its connection with the region to very early times, and in modern times both Catholic and Protestant missionaries have operated freely in Travancore. The state has 3,500 schools attended by over 700,000 pupils; the University of Travancore was established in 1936 at Trivandrum, the capital. There are four first-grade colleges, and colleges for law, teacher-training, and Sanskrit.

The state owes its prosperous economic condition to the wealth and variety of its agricultural products. Pepper, in early times the rajah's most important asset in dealing with Europeans, became in modern times but one in a long list of valuable tropical products: coconuts, ginger, turmeric, tea, cardamoms, tapioca, rubber, blackwood, ebony, and teak. Fish are important as food, as are rice, gram, beans, and yams grown on the plains of the littoral. The state has an excellent system of communication via inland waterways and the South Indian railway system, and the government has directly or indirectly subsidized various types of industrial enterprise. The industrial development of the state depends greatly upon power supplied by the Pallivasal hydroelectric scheme, completed in 1940. There are a ceramic plant at Kundara, a sugar and chemical factory, a rubber-processing plant, and a plywood mill at Punalur, an aluminum smelter and a glass factory at Alwaye, and extensive salt-works on the coast. Further schemes for industrial development were projected after World War II. In the spring of 1949, the governments of India and of Travancore jointly financed a corporation with a view to processing annually at least 1,500 tons of thorium-bearing sands.

**Cochin.** Cochin, with an area of 1,493 sq. mi., lies between the northern boundary of Travancore and the Coimbatore and Malabar districts of Madras. Like Travancore, Cochin has enjoyed an enviable reputation as an enlightened despotism with a high literacy rate and an educational system unique in India. The government supported 217 rural libraries, 719 schools with 229,800 students, 9 first-grade colleges, and a teacher-training college. The rajah's capital in modern times was Ernakulam; the city of Cochin, formerly held by the Portuguese and later by the Dutch, became British territory at the close of the eighteenth century, and hence was politically in Madras. This city, as a result of extensive harbor improvements in the 1930's, is the leading port of southwest India.

Cochin, like Travancore, has an unusually high percentage of Christians in its population. The community of "Cochin Jews," most of whom live outside Cochin in the city of Cochin, are said to have emigrated to Cochin before the ninth century. The economy of Cochin is similar to that of Travancore, except that industrial development is more limited and is confined largely to the processing of agricultural products. Fish, coconut products, and timber have a more important place in the economy than is the case in Travancore. H. Fu.

**TRAVELER'S-TREE,** *Ravenala madagascariensis,* of the banana family, native to Madagascar but grown in other warm climates because of its interesting appearance. It grows as high as 30 ft. The palmlike trunk carries alternate



*Traveler's-tree of Madagascar,* Ravenala madagascariensis, *showing detail of palmlike leaf*

leaves on opposite sides, each leafstalk 6 to 8 ft. long, and the shining leaves 4 to 6 ft. more, giving the tree a fanlike appearance. At the base of the stalks are cuplike enlargements containing a refreshing watery sap sought after by thirsty travelers. The leaves are used for thatch and the stalks for the partitions of native huts. J. C. Wis.

**TRAVERSE CITY** [træ′vərs], a city in the northwestern part of the Lower Peninsula of Michigan, the county seat of Grand Traverse Co., on Grand Traverse Bay, 125 mi. north of Grand Rapids. The city was founded in 1847 and incorporated as a city in 1905. A commission and city manager administer the local government. Traverse City is the headquarters for air patrol of the Great Lakes. The National Music Camp, where summer music courses are held annually, is 14 mi. southwest at Interlochen. Of interest in the city is Clinch Park with its miniature replica of Traverse City. Transportation is provided by the Pennsylvania, the Manistee and Northeastern, and the Chesapeake and Ohio railroads and by the Capital Airlines. Although primarily a resort and an important cherry shipping center, Traverse City has a diversified factory output, including processed cherries, automobile parts, electrical items, sprayers, and iron and steel products. Pop. 1950, 16,974.

**TRAVIATA, LA** [lɑ trɑ′vyɑ′tɑ], an opera in three acts by Giuseppe Verdi with a libretto by Francesco Maria Piave based on *La Dame aux Camélias* by Dumas fils. Verdi wrote the opera in four weeks during his work on *Il Trovatore;* it was first performed on March 6, 1853, in Venice, and contains several of Verdi's most poignant melodies, with ensemble music of great sweetness and sonority. Conceived as a "contemporary" opera, it was first performed in modern dress, and this, combined with a poor cast, made the first

performance a failure. A year later, however, the period of the story was put back 150 years, and since that time the popularity of the work has been uninterrupted.

**TRAWLER.** *See* Fishing Vessels.

**TREASON,** a crime the essence of which lies in the breach of allegiance to a government by a person who owes allegiance to it. The English Statute of Treasons, enacted in 1351, is a principal source of the law governing this crime. It declared seven classes of acts to be high treason. The United States Constitution, Article III, Section 3, in defining treason, limited it to two of these classes, declaring: "Treason against the United States shall consist only in levying war against them, or adhering to their enemies, giving them aid and comfort." Treason by levying war requires in general the actual assemblage of men in force for the purpose of overthrowing the government or to coerce its conduct. It is usually committed in internal insurrections directed by persons within the state. Treason by adhering to enemies is considerably wider in scope. It covers in a broad sense any act clearly indicating a want of loyalty to the government and sympathy with its enemies, and which, by fair construction, is directly in furtherance of their hostile designs. It is generally committed in connection with a war waged against the government by a foreign power. Most of the states of the Union, in their constitutions or statutes, have adopted the words of the federal Constitution in declaring what shall constitute treason against the state. E. O. B.

**TREASURE ISLAND,** a novel by Robert Louis Stevenson, written for his stepson, Lloyd Osbourne, and first published in book form in 1883. It recounts the adventures of Jim Hawkins, the son of an innkeeper on the west coast of England, and of Squire Trelawney and Dr. Livesey in their search for treasure buried by the notorious pirate, Captain Flint. The finding of a map in the sea chest of Billy Bones, Flint's mate, after he has been frightened into a fatal stroke at the Admiral Benbow Inn by the appearance of Black Dog and the blind beggar, Pew, is the starting point for a sea voyage, a mutiny, a long fight on the island between the treasure seekers and the buccaneers, and final discovery of the buried plunder. Stevenson originally called his story *The Sea-Cook,* after one-legged Long John Silver, cook of the treasure ship *Hispaniola,* who had once been Flint's quartermaster. This likable and plausible scoundrel is the story's most colorful character. *Treasure Island* has long been established as the very prototype of the rousing adventure tale of buried treasure. J. P. Wo.

**TREASURY, DEPARTMENT OF THE,** an executive department of the United States Government created by act of Congress on Sept. 2, 1789, and charged with the management of the national finances. Its primary functions are the collection of revenues, the disbursement of funds, and management of the public debt. In addition, the department controls the coinage and printing of money, supervises the national banks, and has general responsibility for procurement of Federal supplies. It is required to maintain a complete system of central accounts for the Government, although audit of accounts is under the General Accounting Office. The Treasury participates actively in advance estimating of tax yields. The Treasury is required by statute to make an annual financial report directly to Congress, but it is considered to be an integral part of the executive branch of the government. Lacking the general powers over budgeting and personnel administration enjoyed by its British counterpart, the United States Treasury has never achieved the pre-eminent status of the British Treasury.

The Secretary of the Treasury is the head of the Department and is appointed by the President with Senatorial confirmation. By custom, he is one of the key members of the cabinet. Alexander Hamilton was the first Secretary, and the post has since been held by many noted statesmen, including Albert Gallatin. In 1950, the bureaus within the department included: Comptroller of the Currency, Customs, Engraving and Printing, Internal Revenue, Mint, Narcotics, Accounts, and Public Debt. Other important subdivisions included various divisions engaged in research, the Office of the Treasurer of the United States, Foreign Funds Control, Procurement Division, United States Secret Service, and United States Coast Guard. R. F. St.

**TREASURY NOTES.** *See* Money (*Monetary Units*).

**TREBLE** [trɛ′bəl], a term in music for high voices, instruments, or parts, synonymous with "soprano" except in the case of "treble clef" and "soprano clef," designations of two different clef signs. W. Li.

**TREBUCHET.** *See* Engines of War.

**TREE, SIR HERBERT BEERBOHM** (1853-1917), English actor-manager, was born Herbert Beerbohm in London, Dec. 17, 1853. He was a son of Julius Beerbohm, naturalized grain merchant of German origin, and a half-brother of Max Beerbohm, the essayist and caricaturist. Herbert Beerbohm made his theatrical debut, under the name of Tree, in *Engineering* (1878). His first great success was as the Curate in William Gillette's farce *The Private Secretary* (1884). Three years later he opened the Comedy Theatre under his own management, and soon moved to the Haymarket, where he won a series of successes with plays by Shakespeare and Sheridan, as well as with such new plays as Oscar Wilde's *A Woman of No Importance* and a dramatization of George du Maurier's *Trilby.* The part of Svengali, in *Trilby,* was one of Tree's most popular roles; other parts in which he excelled were King John, Falstaff, Shylock, Wolsey, Stockman in Ibsen's *An Enemy of the People,* Fagan in

*SIR HERBERT BEERBOHM TREE*

CULVER SERVICE

*Oliver Twist,* and Micawber and Peggoty in a dramatization of *David Copperfield.* Tree was knighted in 1909, and died July 2, 1917, in London. J. Ga. and T. G. R.

**TREE,** a large, woody, perennial plant consisting of a root system with one or more main roots and their branches, and a shoot system comprising normally one stem or trunk with branches and leaves. Shrubs generally are smaller and are characterized chiefly by many stems from the same root. Arbitrary limits to distinguish trees from shrubs in the matter of size have been set by various authorities but are not universally applicable.

The tree varies in size from that of the shrub to the largest organisms of the plant kingdom. Its growth and reproduction is dependent upon the living matter or protoplasm in its cells. Moreover, all plants containing the green pigment, chlorophyll, in the cells of their tissues are able to utilize the energy of the sun which is absorbed by the pigment; they take up carbon dioxide from the air through the leaves and absorb water and minerals through the roots from the soil; with these materials they manufacture food in the form of sugars or carbohydrates. This most important process upon which all life is dependent is called photosynthesis (putting together by light). The food, not immediately utilized for growth, is stored in the form of starch in various parts of the plant, such as the roots, and becomes readily available in this way to other living things. The tree might well be called a natural carbohydrate factory.

*Age and Size.* Trees are perennial, that is, they live from year to year, and some individual trees grow to be the largest and oldest of all living things. As in human families, the qualities of age and size in trees are hereditary. The beech family, containing the beech, oak, and chestnut, is noted for its longevity. A chestnut tree, *Castanea sativa,* on Mt. Etna in Sicily, is estimated to be more than 3,000 years old.

For height and girth, if the eucalyptus of Australia is excepted, the conifers hold the record. The following figures, taken from the U.S.D.A. Conservation Year Book for 1954, refer to the largest trees in the United States.

Largest Trees in the United States

| *Name* | *Girth at 4½ ft. from ground* | *Height* | *Place* |
|---|---|---|---|
| Western red-cedar (*Thuja plicata*) | 62 ft. 8 in. | 100 ft. | Olympic National Park, Washington |
| Redwood (*Sequoia sempervirens*) | 62 ft. 8 in. | 308 ft. | Maple Creek, Humboldt Co., Calif. |
| Giant sequoia (*Sequoia gigantea*) | 101 ft. 6 in. (at base) | 272 ft. | Sequoia National Park, Washington |
| Sitka spruce (*Picea sitchensis*) | 51 ft. 6 in. | 235 ft. | Olympic National Park, Washington |
| Douglas fir (*Pseudotsuga menziesii*) | 53 ft. 4 in. | 321 ft. | Olympic National Park, Washington |

Estimates of 1,000 to 2,000 years have been made for these trees. The giant sequoia, though shorter than its relative, the redwood, has a larger girth and is believed to attain a greater age. It has been estimated that some of the trees were already 2,000 to 2,500 years old at the time of Christ, and that a few may possibly antedate the recorded history of mankind. A tree from the Converse Basin Grove is reported to be at least 4,000 years old.

The so-called Cypress of Montezuma of Mexico, *Taxodium mexicanum,* or *micronatum,* also known as the Tule tree, is located in the cemetery of Santa Maria of Tule in Oaxaca. It is 120 ft. high and has a circumference of 90 ft. at the base. Apparently this is the same tree which Ferdinand Cortez mentions in his history of the development of America. Cortez stated that he could encamp all his troops in its shade. De Candolle has estimated its age as 6,000, while von Humboldt considers it to be 4,000 years old.

The baobab, or monkey-bread tree, *Adansonia digitata,* of French West Africa is also considered to be among the oldest of trees. A specimen of this tree, found at the mouth of the Senegal River and with a trunk diameter of 33 ft., has been calculated to be 5,150 years old.

Although no data are available about their age, the tall eucalyptus trees, native to Australia, should be mentioned. The greatest heights of the eucalyptus species are disputed. Some reports have been made of measurements of over 525 ft. The two tallest species are the Mountain Ash, *Eucalyptus regnans,* and the Alpine Ash, *E. gigantea.* The Mountain Ash is believed to reach a height usually between 300 and 350 ft. Official measurements of different individuals of this species include heights of 326, 347, and 362 ft. It can be seen that they eclipse the height of our tallest redwoods. An individual of another species known as the karri, *E. diversicolor,* was found in an official measurement to be 342 ft. tall, although this species usually does not reach the heights of the other two. The outstanding size can perhaps be better visualized with the information that a karri tree, 265 ft. in height, having a girth of 33 ft. at 4½ ft. from the ground, yielded 62,000 ft. of timber and weighed 120 tons exclusive of the branches.

*Uses.* Trees are of incalculable value to man. The most important use is as a source of construction lumber. Paper manufacture, plastics, and plywood also consume large quantities. Fuel is another important use. The bark of certain species of trees yields cork and commercial supplies of tannic acid for leather manufacture; other species give valuable medicinals such as quinine; some contain flavoring substances, such as cinnamon. Very popular beverages including coffee and cocoa are products of trees. Other trees yield latex, a milky sap from which rubber or chicle is obtained. Economically important gums such as camphor belong to another group of tree products. Some woods give us valuable dyes. The sap of some trees is especially sweet in the spring, the starch stored in the wood during the winter having been converted into sugar. This sweetness is particularly pronounced in the sap of the sugar maple, which when boiled down is known as maple sugar. The nuts and other fruits of many trees furnish food.

In addition to these material uses, trees are beneficial to man in many other ways. When in large numbers, as in forests, they prevent floods and erosion of valuable top soil. When planted in rows or belts they act as wind and snow breaks on the farms of the Great Plains. They serve as game preserves and they offer ideal recreation places for camping, fishing, hunting, hiking, and so on. Not to be forgotten is the value of beautiful trees as ornamental features of the landscape.

*Coloration.* The change from the fairly uniform greens of the foliage to the varied assortment of colors—brilliant reds, purples, golden yellows—in autumn, just preceding the fall of the leaves, actually occurs in only a relatively small portion of the world. In the torrid regions, the trees are green during the rainy season. As the dry season approaches, the leaves turn brown and drop off. Occasionally in areas that usually have autumn coloration the same condition may occur when there has been a long period of severe drought in the summer. In temperate regions, however, where the supply of moisture is normally more moderate and con-

tinuous throughout the year and a warmer period alternates with a cold one, coloration occurs. In the southern hemisphere, such a region exists in only a small portion of southern South America. In the northern hemisphere, it covers parts of eastern Asia, southwestern parts of Europe extending northward along the Atlantic coast and eastward through southcentral Europe, and the eastern section of North America. The most beautiful autumn coloration occurs in the northeastern section of the United States, namely, new England, and adjacent Canada, where conditions are ideal.

During the summer, leaves are green because of the abundance of the green pigment, chlorophyll. This substance absorbs all of the light waves, with the exception of the green which it reflects, and these light waves, principally the red and the violet, are used by the leaf to obtain the energy needed in the process of photosynthesis. Chlorophyll is not a "fast" color; throughout the growing season it is continually being destroyed and replaced each day by fresh supplies. In the autumn, because of lowered temperatures and other factors, "old age" of the leaf sets in, the leaves become less and less active, and the chlorophyll is manufactured less rapidly.

As the chlorophyll gradually disappears, other pigments, some of which have been hidden by the chlorophyll during the growing season, begin to show their colors. The carotinoid, or yellow and red, pigments are present in the leaf during the summer in the same plastids or protoplasmic bodies that contain the chlorophyll. Their function is not certain. The principal carotinoid pigment is xanthophyll, a yellow substance which is responsible for much of the yellow in autumn foliage, as in the birch, tulip tree and elm. Xanthophyll is more resistant than chlorophyll to the destructive action of light. Carotene, another pigment, may also be present, imparting a red or orange color. Other reds, as well as the purples and blues, are due to the presence of anthocyanin, a pigment of variable color, in the cell sap. An early frost will destroy the yellow pigments and prevent the production of anthocyanin. The latter pigment develops in the fall with the disappearance of the chlorophyll, with the accumulation of sugar in the leaf, and in the presence of strong sunlight. Low temperatures, but not frost, also promote the production of anthocyanin. In alkaline soils the pigment tends to be blue or purple, while in acid soils it is red. The brilliancy of sumacs, sweet-gum, various oaks, and other trees is due to the presence of this pigment. In many cases it finally undergoes oxidation, which results in a brown color. With a little practice one can recognize many kinds of trees at a distance by their autumn hues.

Autumn coloration can occur only in those species of trees and shrubs which are able genetically to produce the appropriate pigments. For example, the sugar maple, dogwood, sumac, red oak, and sweet gum are among the most favorable types. Coloration develops to the fullest extent when the summers are not too dry, when the temperatures become low without heavy frosts as fall approaches, and when the weather continues sunny, clear, and cool for a long continuous period.

*Poisonous Trees.* Many of our common trees possess, surprisingly, some poisonous qualities. Actually, almost any plant could thus be classified, if all those effecting allergic reactions in individuals were included. The poisons that are produced in the stems, leaves, roots, flowers, fruits, or the sap may be classified chemically as alkaloids, glucosides, organic acids, resins, volatile acids, and others which are not yet identified. Their irritant or toxic effect may occur on the skin, on the nervous system, in the blood, or in the muscles. In the following table are presented a number of those trees which contain specific substances known to be toxic to animals and human beings. In general, all of those listed have an effect only when eaten, with the exception of poison sumac whose oil produces an irritation of the skin in many people on contact with any part of the plant.

TREES CONTAINING POISONOUS SUBSTANCES

| *Tree* | *Poisonous substance* | *Location* |
|---|---|---|
| Balsam poplar | Glucoside | Leaves |
| Black locust | Glucoside (robinin) | All parts |
| Boxwood | Alkaloids (buxine and buxidine)<br>Oil (oil of euphorbia) | All parts |
| Catalpa | Glucoside | Bark and fruit |
| Cherry (also plum, peach, and apple) | Glucoside (amygdalin) | Leaves and seeds |
| Chinese tung-oil | Glucoside (saponin) | Leaves and fruit |
| Ginko | Resin | All parts |
| Hemlock (also Norway spruce and others) | Resin | All parts |
| Horse chestnut | Glucoside | Leaves and fruit |
| Kentucky coffee tree | Alkaloid (cytisin) | Leaves and fruit |
| Magnolia | Glucoside | Leaves |
| Manchineel tree | Oil (Oil of euphorbia) | Sap |
| Pacific yew | Alkaloid (taxine)<br>Oil (oil of yew)<br>Acid (formic acid) | Leaves and fruit |
| Poison sumac | Oil (toxicodendron) | All parts |
| Tree-of-heaven | Glucosides (ailanthin and saponin) | Bark |
| Tulip tree | Alkaloid (tulipiferine)<br>Glucoside | Flowers |
| Walnut | Acid (juglandic acid) | Bark |

## STRUCTURE AND FUNCTIONS OF THE PARTS OF THE TREE

**Stem.** The trunk or stem of the tree and its branches are composed of the following parts: (1) outer bark, (2) inner bark, (3) cambium, (4) wood, and (5) pith.

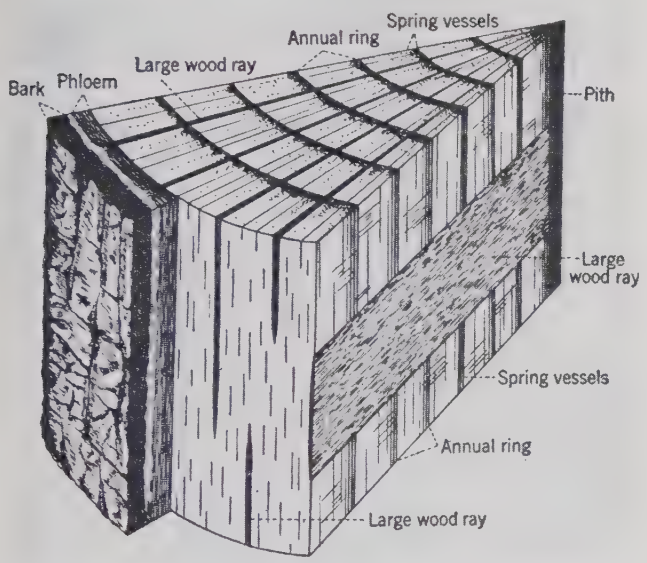
*Outer Bark.* In the young tree plant the outer bark is very thin and is merely the single epidermal layer of the stem which was produced along with the rest of the primary growth. As the tree becomes older, secondary growth is initiated by the formation of an inner cambium or growing layer of cells which produces tissues known as xylem and phloem. (These tissues are described later on.) At this stage of development another kind of cambium called the cork cambium develops beneath the epidermis in the outer portions of the phloem. This cambium produces (to the outside) cells whose walls are impregnated with a waxy substance which is called suberin and is impervious to water. The amount and manner of this bark or cork development vary in different species and result in the characteristic bark of the species.

A feature of the bark in the young stages is the appearance of the lenticels, small dots which indicate the presence of openings through which there is an interchange of gases within the tree and the air without. In the young tree or small twig these lenticels usually have a gray or white color,

but as the tree or branch increases in diameter these dots become lengthened until they appear as transverse lines in the bark.

The function of the dead outer bark is important since it serves to protect the interior parts of the tree from rapid changes in temperature and from invasion by organisms causing disease. Sometimes, indeed, it is of such thickness that it can protect the interior from the heat of a forest fire. The bark of old redwoods is very thick and offers much resistance, but young trees with thinner bark are quickly killed by a light ground fire. This thickness of bark is a critical factor in forest fires. However, the roots usually escape injury in a light fire so that sprouts soon appear. These may equal the old growth in a few years.

*Inner Bark.* The inner or living layer of bark is easily distinguished from the outer layer by its paler color. It can be observed by making a slanting cut on the surface of the tree. It is yellow in the black oak and pinkish in the red

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*Pie-section of an oak log. The block shows the three cutting planes: radial, at right; transverse, above; tangential, side with bark partly removed.*

and scarlet oaks. This layer contains conducting tissues functioning in the transport of organic food substances such as the sugars to the growing regions of the tree. It is called the phloem. The phloem cells are of several kinds and differ from the wood cells later described in the fact that they are for the most part living cells. The conducting or sieve cells in the gymnosperms are joined together in the angiosperms to form a sieve tube. The sieve cells or sieve tube elements have perforated areas known as sieve plates on the side or end walls. Adjacent to them in the angiosperms, but lacking in the gymnosperms, are smaller cells called companion cells. In addition, there are fiber cells, non-living with thickened walls, which have a mechanical, protective function.

Since the phloem carries organic or manufactured food to regions of growth, it is of the utmost importance that the flow be uninterrupted. Hence it is that a girdled stem dies or soon will do so. Such a stem has its bark ringed around by a cut as far in as the wood. The roots and in particular the growing points near their tips can then receive no food. This situation applies also to the constriction of the bark when encircled by chains, iron bands, or even strong ropes, as is sometimes done to prevent trees with forked trunks from splitting apart. The only practical prevention in such a case is the use of an iron rod, passing it through the approximate center of the forked branches and securing it firmly at each end.

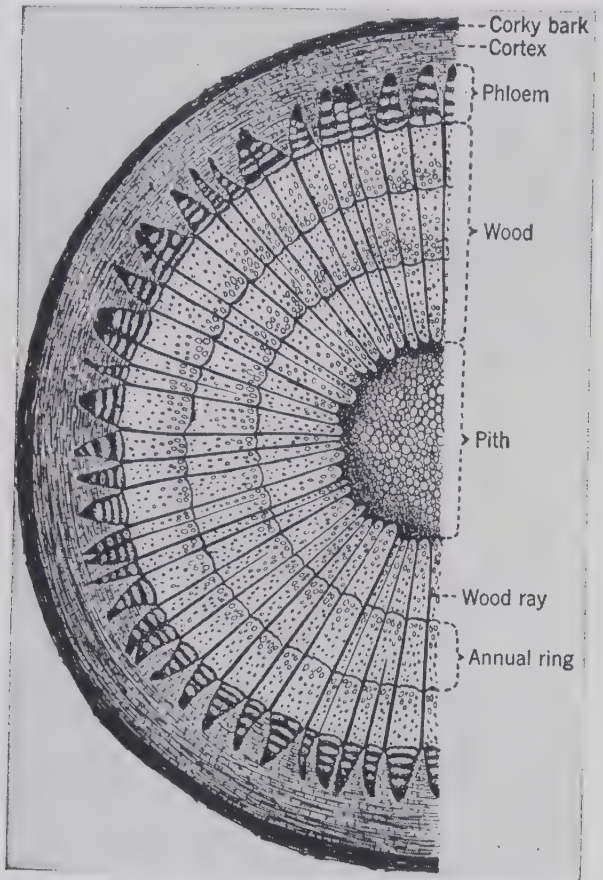
*Cambium.* This is a layer of cells capable of active growth and division, situated between the inner bark and the wood, the latter being known botanically as the xylem. The cambial cells are in shape like long, flattened, four-sided boxes, their wider dimensions being more or less parallel (tangential) to the outer surface of the trunk, and fitting together above and below by beveled ends. They are filled with protoplasm (the living matter) and during the growing season are continually increasing in size and dividing, differentiating new wood cells on their interior side and new phloem cells on their exterior, but usually forming more wood than phloem cells. Thus this cylinder of actively dividing cells is constantly advancing outward and therefore increasing in circumference, leaving behind each year a ring of wood cells, and forming in front a much thinner ring of inner bark. Due to the mechanics of this process a continually increasing pressure is exerted upon the outer layers of the bark which results in cracking, fissuring, and exfoliation of these outer layers.

*Wood.* The primary function of wood tissue or xylem is to carry water and mineral solutions, known as "sap," upward to the leaves. For this purpose many of the wood cells which are derived from the cambium are much elongated in the direction of the tree's length. These elongated wood cells which function in sap transport are of two kinds. The larger vessel-segments are cells with perforated end walls joined together vertically to form "vessels." The smaller elongated cells known as tracheids have small openings known as "pits" scattered in the radial and end walls. There are also wood fiber cells which are elongated, thick-walled cells functioning in support. The tracheid is the only type of conducting cell found in the gymnosperms. The wood cells, as do all true plant cells, possess cellulose walls, usually a primary wall and an inner secondary wall which develops after the cells have completed their growth and elongation. However, wood cells, in addition, undergo a process known as lignification in which a substance called lignin impregnates the cellulose wall giving the hard and woody character to this tissue. In the economy of the plant, lignin serves a double purpose. It does not have the stretchability of the ordinary cellulose wall and so lends rigidity to the tree; nor does it absorb water and swell as can the cellulose cell wall; and yet water passes through it with great rapidity and ease. Thus it is admirably suited for conducting the sap stream up the tree. Parenchyma cells, comparatively thin-walled and with shorter dimensions, functioning in storage of food or by-products such as resins or gums, are also present in the wood. As the living wood, or sapwood, becomes older its cells die and are infiltrated with various substances which darken the color of the whole. It is then known as heartwood and its only function is to support the tree. The importance of this function can be realized when one sees the ease with which hollow trunks in which the heartwood has rotted out are overthrown in windstorms.

Because the first wood cells formed by the cambium in the spring of the year usually have larger cavities and thinner walls, a contrast between spring and summer wood is clearly evident in any cross section of the trunk, in most cases even to the naked eye. The whole thickness of this ring of wood formed in any given year is called the annual

ring, although some authorities apply this term only to the boundary line made by the contrast between the thick-walled summer wood of one year and the thinner-walled spring wood of the next. By counting these annual rings the age of the trunk can be approximately determined.

A method of dating ancient pieces of wood known as cross-dating has lately been developed out of this knowledge.

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*Transverse section of a three-year-old tulip tree twig.*

It can be applied in dry regions like our arid southwest where a single factor, that of rainfall, determines the width of an annual ring of wood. Therefore, the proportionate widths of the rings in all of the trees in a given region will correspond. Series of large and small rings can be found which, in their succession, are absolutely distinct and follow a definite pattern. Beginning with any ancient beam or piece of wood, its rings can be matched at some point with those of a younger beam, and so on through still younger beams down to the present, perhaps with the stump of a recently felled tree. Counting backward, the ancient beam can thus be dated.

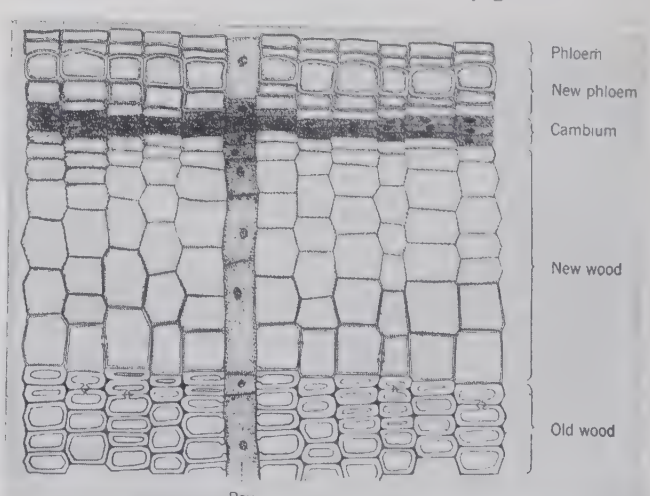
The method, however, is not always entirely reliable. For example, if the tree becomes defoliated by insects new leaves may be put forth and new growth of the stem and its branches results in the same season; or similarly, if, after a drought, a change in the weather more favorable to growth occurs, new leaves may be developed and a second ring of growth formed in the same year. As a matter of fact, such secondary growth, if caused by insect defoliation, results in a weakening of the tree, since it is accomplished by immature buds intended for the following year, and the new growth has little time to form satisfactory buds for the next year.

In the tropics because of the irregularity or absence of change in the seasons, the annual rings are often indistinct. Here, differences between wet and dry seasons may result in annual rings.

*Pith and Pith Rays.* At the center of the tree trunk or branch is an area of loose, comparatively thin-walled tissue called the pith. In the older and larger tree trunk, the proportion of pith is so small as to be almost invisible. Around this tissue the conducting or vascular system of the tree has developed, and from it, radiating outward into the bark, are plates of thin-walled tissue called the medullary or pith rays, which besides providing for a lateral communication between the wood cells, cambium, and living bark, sometimes contain a store of reserve food during the winter season. These rays do not all extend as far as the pith. New ones are continually being formed by the cambium along with its increase in circumference. The thickness of these rays varies in different kinds of wood. Thus in a log of oak they are prominent in the cross section and they impart the characteristic grain to the "quartered oak." In other woods, such as the maple, the rays are barely distinguishable to the naked eye. In any classification of woods their prominence is of special significance as a diagnostic feature.

The above describes the characteristic internal appearance of trees which belong to the gymnosperm group (conifers and relatives) and to one group (dicotyledons) of the angiosperms or flowering plants. However, in trees which belong to the other members of the angiosperms (monocotyledons) the arrangement differs. The stem or trunk consists of (1) outer bark and (2) inner cylinder of vascular tissue. The structure of the bark varies with the species. In some the successive layers are produced much as in the other groups. In others, bands of bark tissue are produced which join together to form a complex irregular mass covering the stem. In still others such as the royal palms, it is persistent and covers the entire surface with a relatively thin layer.

In the monocotyledons the xylem and phloem tissues are found in clusters known as bundles which are scattered throughout the stem embedded in a less specialized tissue. There is no definite pith region. Secondary growth from a special cambium does not occur. There are no annual rings. In a few tree forms of such plants as *Yucca, Aloe,* and *Dracaena,* the stem is increased somewhat in diameter by the

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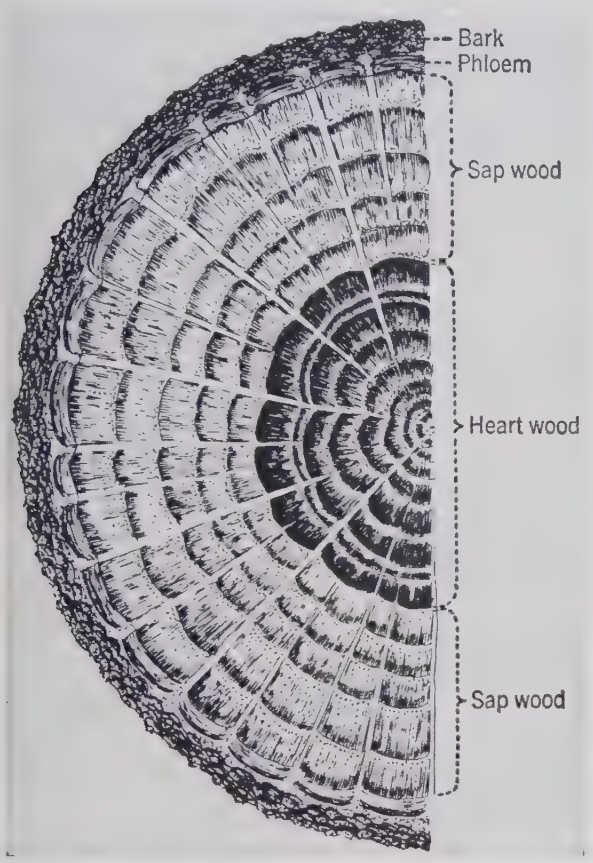
*Portion of a transverse section of a pine stem, much enlarged, showing cambium, wood, and phloem cells.*

development of new cylinders of bundles of vascular tissue. The main growth in such trees is in length due to the terminal growing point. As is easily observed, such trees seldom, if ever, branch, but consist of a straight unbranched trunk with a cluster of leaves at the apex.

**Flowers and Fruit.** One of the chief functions of the stem of a plant is to bear the flowers and fruit to assure the reproduction of the species. In some kinds of trees the flowers are either minute or inconspicuous as in the elm or are borne so early in the season as in the maple that they escape notice. In others such as the horse chestnut and our

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*Transverse section of an oak log showing heartwood and sapwood.*

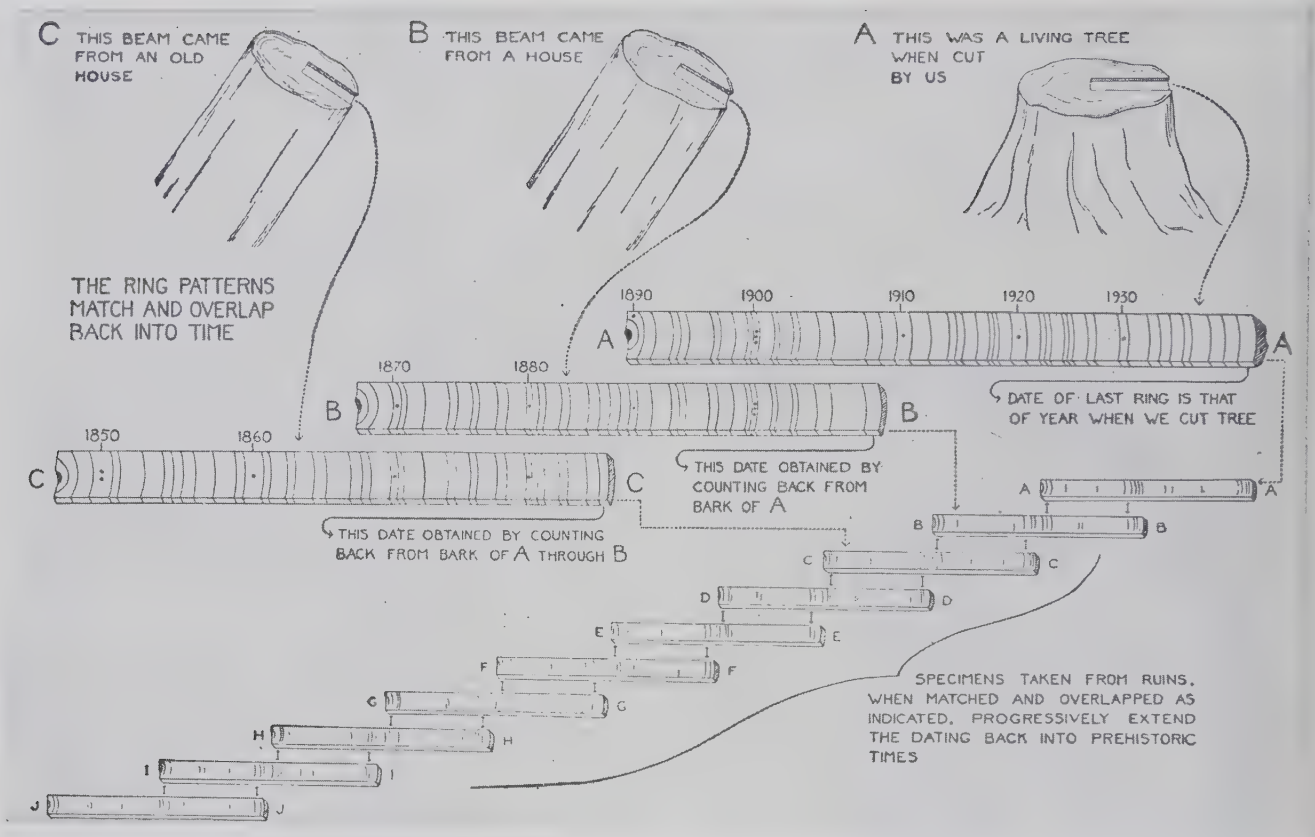
cultivated fruit trees, they are large and very attractive. Many trees must grow for at least a dozen years before any flowers are borne. The flowers possess the usual sexual organs, the pistils and stamens, which may be in the same or different flowers, and the accessory parts, the petals and sepals. In certain species, the two types of flowers are on the same tree as in the oak, hickory, and birch. In others, the male and female flowers are borne on different trees, for example, in the willow, poplar, and gingko. As the fruits of the gingko have a disagreeable odor, it is possible to avoid them and yet enjoy this easily grown, attractive tree by planting only the male forms. In the conifers, the ovulate scales and stamens are usually produced in very unlike cones. The ovules are borne in the pistils or ovulate scales and the pollen grains develop in the stamens. The latter, on reaching the pistils or ovulate scales by means of insect or wind pollination, form pollen tubes which grow into the ovule, carrying with them the sperm cells, one of which unites with the egg in the ovule. From this fertilized egg, by growth and continued cell division, a tiny embryo develops; this embryo and certain of the surrounding tissues eventually form the seed. Some trees can also reproduce asexually, that is, without seeds. The willow is an example. Its brittle branches which break off, fall to the ground, or perhaps are carried off some distance by a nearby stream, take root easily and grow into trees.

**Leaves.** Although all living parts of the tree co-operate in its life processes, the leaves may be regarded as the most important organs, as in them are first formed the organic foods which serve as a basis for growth and development. To the casual observer, a leaf is just a leaf and nothing more. And yet, on its structure and functions all life, animal as well as plant, is ultimately dependent. For here, within countless green cells, photosynthesis takes place. This process in which sugar, the first organic product, is produced, is of such vital importance to all life that scientists have long endeavored to understand and imitate it and thus make sugar (or carbohydrate) artificially. It has been shown that white or albino leaves or white parts of leaves in which chloroplasts are completely absent, cannot photosynthesize at all, and in order to be kept alive must be supplied with food material from other green parts of the plant, or if isolated, the culture medium must contain some form of sugar, preferably sucrose. Pieces of green leaves can easily be kept alive and functional in a culture medium which supplies water and minerals in solution. More recently, the chloroplasts themselves have been isolated outside of the cell, and these green bodies are able to carry out *in vitro* in the presence of carbon dioxide and water several of the intermediate steps in the process of photosynthesis in the same way as it occurs in the leaf. The studies carried out with these isolated chloroplasts have shown that chlorophyll can convert light energy obtained from the sun into chemical energy in a certain form which is then used in the complex cycle of chemical reactions that follows in the process leading to the ultimate production of sugar. A number of the steps in the process have also been carried out *in vitro* by the use of cell-free extracts without the presence of chlorophyll or light.

The sugar of photosynthesis, in solution, is combined with various minerals, particularly those containing nitrogen, to form proteins, a process which it is now believed is carried on partly in the leaf but mainly in the growing points or wherever a supply of actively growing living matter or protoplasm is at hand. The sugar that is not utilized immediately in this way is converted into starch and stored in various parts of the plant, such as the cortex of the root and stem and the pith of the latter.

If one considers a typical leaf, it becomes clear how well it is constructed and adapted for carrying on its important work. It is composed of a blade and stalk or petiole, although some leaves lack the stalk and then are called sessile. The point of attachment of the leaf is known as the node; the region from one leaf down to the next one on the stem is the internode. The blade of the leaf is thin and flat and arranged in such a way that it is more or less at right angle (or perpendicular) to the light rays. The latter penetrate to all its parts. It is also provided with a multitude of openings known as stomata (singular, stoma) which admit air with its quota of carbon dioxide for photosynthesis and oxygen for respiration. These openings also give off the water of transpiration in vapor form and the carbon dioxide and water which are released in respiration.

The internal structure of the leaf is also such as to pro-


C THIS BEAM CAME FROM AN OLD HOUSE
B THIS BEAM CAME FROM A HOUSE
A THIS WAS A LIVING TREE WHEN CUT BY US
THE RING PATTERNS MATCH AND OVERLAP BACK INTO TIME
1890
1900
1910
1920
1930
1870
1880
1850
1860
DATE OF LAST RING IS THAT OF YEAR WHEN WE CUT TREE
THIS DATE OBTAINED BY COUNTING BACK FROM BARK OF A
THIS DATE OBTAINED BY COUNTING BACK FROM BARK OF A THROUGH B
SPECIMENS TAKEN FROM RUINS. WHEN MATCHED AND OVERLAPPED AS INDICATED, PROGRESSIVELY EXTEND THE DATING BACK INTO PREHISTORIC TIMES

COURTESY OF W. S. STALLINGS, JR. AND THE LABORATORY OF TREE-RING RESEARCH, UNIVERSITY OF ARIZONA

*Method of dating ancient pieces of wood.*

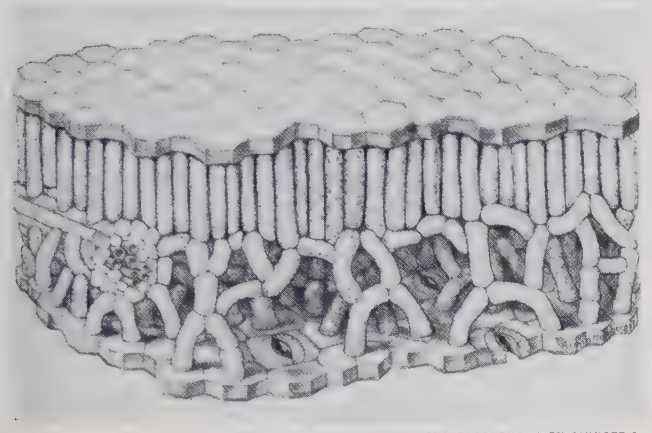
vide for its most efficient functioning in the process of photosynthesis. A typical leaf has lower and upper outer, nonchlorophyllous layers, one cell deep. They are known as the epidermis and contain the stomata through which gaseous exchange occurs. Just below the upper epidermis there is a compact layer of columnar-shaped cells, the palisade layer, containing many chloroplasts. Beneath that and above the lower epidermis is a layer of irregularly shaped and arranged cells, the spongy layer, also containing chloroplasts. The former carry on photosynthesis to the greatest extent, and the latter provide the necessary large surface areas for the exchange of carbon dioxide, oxygen, and water vapor. Running into the leaf from the stem and forming the vein pattern or venation is the vascular tissue of xylem and phloem through which water is transported from the roots and the synthesized material is carried away.

The majority of the broad-leaved trees and a very few conifers (such as the tamarack and bald cypress) are deciduous; that is, they shed their leaves every year. Usually, late in the autumn in temperate regions, a special layer of cells, the abscission layer, begins to form across the base of the petiole or stalk of the leaf. This becomes a region of weakness so that eventually the leaf severs its connection with the tree and falls to the ground. A leaf scar remains on the stem in which may be seen the bundle scars which are the ends of the system of veins into the leaf.

In a large number of the conifers, in many tropical species, and in some broad-leaved trees of the temperate zone, leaves are retained for more than one season and are then known as evergreens. This fact does not mean that the leaves persist indefinitely. The length of time before an abscission layer forms and the leaf drops off, however, is longer and varies. For example, the needle leaves of the conifers may remain on the tree for 3 to 5 years. Only in some trees, such as the palm, does an abscission layer not develop. Such leaves remain until weathering finally disintegrates them completely.

*Winter buds.* Buds are found by examining the end of a woody stem and the axils of the leaves, that is, the angle between the stalk of the leaf and the stem. These buds are composed ordinarily of scale-like leaves (bud scales) on the outside and tiny embryonic leaves within which surround a central cone or growing point. The growing point consists of embryonic cells which, in the growing season, are constantly growing and dividing, forming new embryonic leaves and perhaps embryonic flowers. In our hardwood and coniferous trees, these "winter buds" contain by the end of summer all of the leaves and flowers in embryonic form that will appear when the "buds are shooting" in spring or early summer of next year. Such "shooting" occurs with the advent of warm weather, in temperate regions in late April or early May. It consists practically of an "untelescoping" or unfolding of all parts of the bud; thus the nodes or joints where the embryonic leaves of the bud occur become separated, the internodes being lengthened so that in the horse chestnut, for example, we find in a few days a growth in length of several inches. Immediately upon the unfolding of the leaves, the formation of buds for the following year commences in the axils and at the ends of the stem and its branches. Where the outer scales drop off at the commencement of the "shooting" process they leave tiny rings, and these, of course, mark the beginning of the year's growth in length of the branch. By counting these rings backward the age of the branch or of the whole tree may be estimated.

Most trees in temperate regions, for example, the hickory, birch, and maple, complete their growth in length sometimes in a few weeks or at most by midsummer. In such



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*A small piece of a leaf blade, greatly enlarged, shown in three dimensions. The upper epidermis, palisade layer, spongy layer with a vein, and lower epidermis with stomata are visible.*

trees the growth is called definite or determinate. In some instances, the growth in length may continue until stopped by the frosts of autumn. This is then called indeterminate growth.

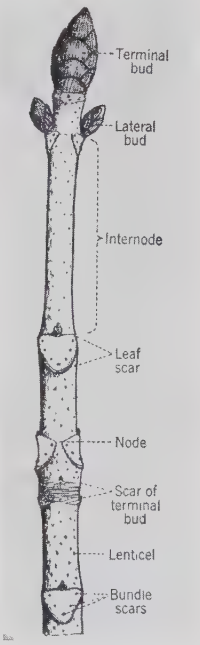
**Root.** The form of the root and its branches and their relative depth in the soil vary with different kinds of trees. In general the oak has long, more or less vertical roots (tap roots), but some kinds, like the pin oak, have a shallow, much-branched root system. Trees with a shallow root system are an easy prey in violent windstorms. Some trees have what appears to be a horizontal root, in reality an underground stem, which sends up shoots at intervals to form a thicket. It occurs in the black locust and various sumacs. A different arrangement is seen in the banyan tree, a native of tropical Africa and India, which sends some of its branches downward to the ground where they take root and form new trunks. In this way a large forest is eventually formed. The banyan tree under which Alexander the Great camped and which is said to have sheltered 7,000 men measures more than 2,000 ft. in circumference and has over 3,000 trunks. The mangrove tree of tropical shores puts out a series of prop roots after the fashion of the midseason roots of our maize or Indian corn. The seeds of this tree germinate while still on the tree and are so weighted that they drop into the water with the root pointing directly downward. By these means the mangrove makes extensive thickets which hold down the soil.

The internal structure of the root is basically the same as that of the stem. However, the arrangement of the tissues differs somewhat. The outer layer of the root, the epidermis, is one cell in depth in the younger parts and the rootlets, whereas in the older parts a bark tissue is produced as in the stem. Behind the protective root cap at the very apex of the root is the growing region. Just behind the tip is the root hair zone where the cells are still rather immature. The epidermal cells of this region possess fine long projections known as root hairs. Further back of the root hair zone the tissues become matured and differentiated. Beneath the epidermis is a layer of parenchymatous cells known as the cortex which is eventually sloughed off in older roots. The innermost layer of cells of the cortex is known as the endodermis. Adjacent to it is a layer of cells known as the pericycle. The pericycle is considered to be the outermost layer of the vascular system. The xylem and phloem in roots are usually in an alternate or radial arrangement which differs from that of the stem. There is no pith. In older roots, a cambium develops which then produces cylinders of xylem to the inside and phloem to the outside in exactly the same pattern as in the stem, so that rings of woody growth also appear.

Branch roots develop internally from a group of cells in the pericycle, rather than from lateral buds on the surface as in the stem. This group of cells undergoes rapid division in an outwardly direction through the cortical and epidermal tissues to ultimately reach the outside.

The chief functions of the root system are (1) to absorb water and mineral solutions from the ground and (2) to hold the tree in place. Absorption of the water and minerals takes place mainly through the root hairs. The root hairs in their growth weave about among the soil particles which, except in very dry soil, are surrounded by a film of water containing mineral solutions. By osmosis, a kind of diffusion, the soil solutions pass through the permeable wall of the root hair and thence are transported through the conducting tissues up the root and into the conducting tissues of the stem.

These delicate root hairs and the fine branch roots are the principal reason for care in transplanting woody or in fact any of the flowering plants. Exposure to the sun or wind dries them out very rapidly so that the tree cannot absorb its customary amount of moisture when transplanted to its new position. Furthermore, because digging around the plant preparatory to transplanting is certain to cut off some of the roots, a considerable amount of the shoot system must be pruned after the tree is set in its new position. Usually about one third of the latest year's growth is cut off. This is of the utmost importance. The reason is that a healthy tree always has a sufficient absorbing system in its roots to supply the leaves with the water they need. If some of this absorbing system is removed, the leaves will wilt. Therefore,




*Horse chestnut twig in winter condition.*

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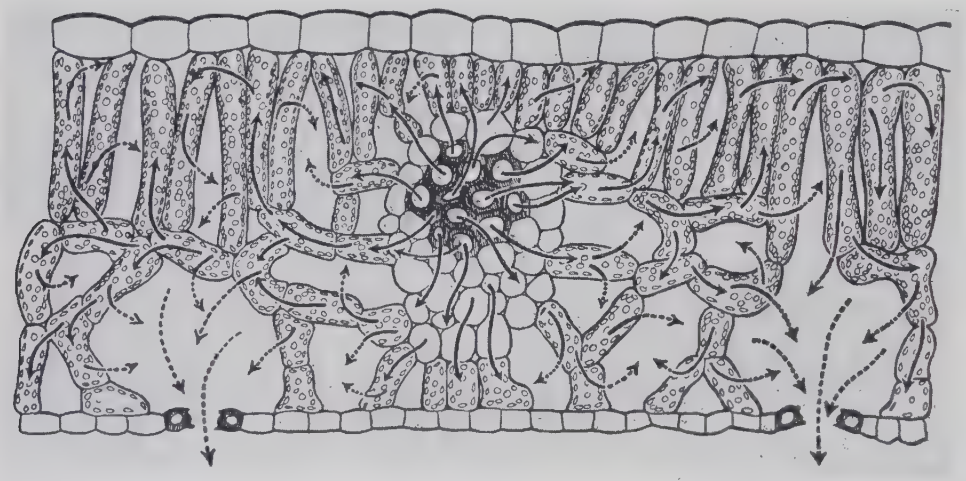
enough of the stem must be pruned away to bring about a balance between roots and leaves. This fact explains why trees are best transplanted in the dormant season, that is, in the fall when the leaves are dropped or in early spring before the leaves of the new year have been unfolded. Even here, however, pruning is necessary against the time when the leaves will appear. Failure to prune often results in the death of the transplanted tree.

### WORLD DISTRIBUTION OF TREE TYPES

In the following section the types of trees will be briefly outlined in relationship to their physical environment, that is, in their ecological relationships. The factors which determine this distribution of trees on the earth's surface are in the order of their importance: (1) Temperature. Great differences exist in the cold-resistant power of the various species, but there are certain limits beyond which a given species cannot survive. This situation is of course dependent, basically, on the sensitivity of the living matter or protoplasm, which varies in different species and even in different individuals of the same species. There may, indeed, in any given locality occur a succession of years with fairly uniform mild weather, but it is the extremely low temperature which occurs only at long intervals of perhaps a score or more of years which is the leading factor as to whether a species will live or can be grown. It should be added that it is often the sudden extreme cold that kills. Bud scales, hairy coverings, thick epidermis, dead and dry outer bark, the presence of oils or sugars in the cells—all these and others are means of protection against a gradual drop in temperature, but may fail when a sudden drop occurs so that the protoplasm cannot adjust itself to the rapid change in temperature. (2) Water. Without water a plant cannot live, and from the above it will be seen how important water is in the distribution of trees. (3) Previous geologic history. In former geologic times the distribution of land masses was much different. For this reason certain kinds of trees occurred in areas now widely separated, in which regions they have often undergone evolution. (4) Other factors, such as the physical character, chemical content, and acidity of the soil, velocity, and amount of wind.

The extreme northern part of North America and Eurasia is known as the arctic tundra, a region of low temperature, often perennially frozen subsoil and drying winds, with a short season for growth during which the daylight is very long. The few trees here are mostly dwarf birch, willow, and juniper. South of this region of arctic vegetation, extending across Canada, Scandinavia, and northern Russia and Siberia, is a broad belt of coniferous forest, the principal species being spruce, larch, fir, and pine, and also some poplar and birch.

South of the coniferous belt is a broad band with various tree types, depending on temperature, precipitation, wind, and man's influence. Beginning with the eastern section in the United States many deciduous trees occur, mixed with conifers in the Appalachian region. Characteristic kinds are elm, maple, beech, oak, hickory, white pine, and hemlock. Related species of most of these trees are found in corresponding areas in Europe, China, and Japan. In the interior parts of the United States the vegetation changes as we proceed westward from the Appalachian. First are the prairies, with little tree growth, now largely given up to agriculture; then with the decreasing rainfall, the Great Plains, mainly grassland; and toward the west and southwest, a semi-desert region. In Europe the plains of Hungary and southern Russia are like our prairies, and with decreasing rainfall these merge to the eastward into grasslands like the Great Plains of the United States. Influenced largely by abundant rainfall and high humidity in the Pacific Coast region, a luxurious growth of conifers occurs from British Columbia to California—redwood, bigtree, red fir, larch, and pine.



*Cross section of a leaf blade showing the path of water (solid arrows) and water vapor (dotted arrows) from a vein through the leaf cells into the air spaces and out through the stomata in the process of transpiration.*

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Farther south in the warmer, moister regions of eastern North America, comes the pine belt. The Gulf States have live-oak and bald cypress, but in the dry southwest are found mesquite and acacia. The plant life of the Mediterranean region is similar in character.

All these changes in tree growth as we travel southward from the Arctic are repeated in the high mountain areas of the tropics or even in the Rockies and the Alps. At the summit of these ice-capped mountains we find the arctic vegetation, farther down come the coniferous species, and next the broad-leaved deciduous trees mixed with conifers, and finally, if we are in the region of the lofty Himalayas, the luxurious tropical tree growth at the foot.

In the broad belt between the Tropics of Cancer and Capricorn, the conditions at low altitudes are ideal for tree growth wherever rainfall is abundant, as in the Amazon Basin, much of Equatorial Africa, India, Burma, and the East Indies. Tall trees make a dense cover and many woody

vines twine around the trees. Epiphytes or "air plants," mainly orchids and members of the pineapple family known as bromeliads, grow on the tree trunks. Growth is so rapid in these tropical forests that a clearing returns to a wild state in a few months. The tree species are numerous compared with those of temperate regions, and a few species do not dominate the vegetation as in the northern forests. However, in a large part of the tropics tree growth is comparatively rare. Much of central Africa, a high plateau, is grassland. In the Sahara Desert, Arabia, and much of interior Australia, rainfall is so scanty that there is relatively little tree growth.

South of the tropics there is no large land mass as in the north temperate zone and there are no large forests. In western Paraguay and Argentina the pampas or grassy plains resemble our prairies, but in parts of Chile where rainfall is high there are evergreen forests somewhat like those of the Pacific Coast of North America, which have been described above.

## TREES IN RELATION TO MAN AND HIS ENVIRONMENT

**Weather and Climate.** By "weather" is meant the conditions of air pressure, atmospheric moisture or humidity, the wind, sun, clouds, and rain from day to day; by "climate" is meant the average weather over a long period for any given region. There is a prevalent belief that trees have an important effect on weather, but, according to the most up-to-date research, the effect is slight. It is an established fact that trees give off, mainly through the stomata in their leaves in the process known as transpiration, enormous amounts of water during the growing season. A medium-sized elm tree gives off more than a ton of water a day, and an acre of beech trees 30,000 barrels in a summer. But this water vapor becomes quickly merged with the great volume of the upper air currents so that its effect is practically negligible. Weather is controlled by a world-wide distribution of temperature, barometric pressure, and wind, that is, by the general circulation of the atmosphere in the higher strata far and away beyond the effect of any local contribution such as might result from a few trees or even from a forest. Of course, within the forest it is cooler, the wind is practically nil, the air is moister, and the shade is an important factor, so that it might be said that the forest has a pronounced influence on the weather. But this condition is true only of the weather in the forest, not out of it. It is the protection that the forest or even one or more large trees offer to other smaller plants, and also animals, that is of significance with regard to weather conditions.

**Erosion.** Although trees have little effect on the weather and climate as a whole they are of tremendous importance in preventing erosion, that is, the wearing away of the soil. When the rain falls, part of it is intercepted by the leaves and branches of the tree and much of this is evaporated, but the larger part drips to the ground where it joins the rest of the rainfall and sinks into the forest floor. There is some evaporation there and also transpiration of moisture from the leaves, but if there is an abundance of leaf mold and litter much of the water is absorbed as by a sponge, and when that surface layer becomes saturated the excess sinks to lower levels where it joins the water table. Thence it moves slowly through the subsoil toward the streams, maintaining their flow. Another favorable influence of the forest is seen in the slower melting of the snow. In this way it also helps to regulate streamflow. If, on the other hand, there are no trees or vegetative cover of any sort, the water runs off quickly, picking up particles of soil as it goes, and thus wears down or erodes the soil. These facts show why forests are necessary for water sheds and why reckless cutting often results in flash floods and gullies that carry away valuable topsoils, dams, and bridges and even sometimes change the course of streams.

**Wounds.** The exposure of living cells of the inner bark of a tree due to hail, wind, insect puncture, or human agency makes an easy entrance for fungi and insects, resulting in disease or even death of the tree. Whenever a wound is thus made the surrounding healthy tissues immediately take up the work of healing the injury, their cells growing and dividing and forming what is known as a callus. If the wound is not large the callus tissue quickly meets from all sides, thus completing the healing process. In many of the conifers the resin canals, which traverse the bark and often also the wood, fill up the wound with resin, thus effectively shutting out disease organisms. In cutting limbs from trees care should be taken to saw the limb off flush with the trunk so that a callus can grow out on all sides of the cut, eventually

Four Major Fungal Diseases of Trees

| *Disease* | *Fungus* | *Tree* | *Effect* | *Treatment* |
|---|---|---|---|---|
| Chestnut blight | *Endothia parasitica* | Chestnut | Attacks living bark and girdles trunk, killing tree | Removal of diseased trees. Development of resistant types. |
| Dutch Elm Disease | *Ceratostomella ulmi* | American elm | Plugs up wood cells. Causes wilting of leaves. Produces a poison which kills tree. | DDT spray to kill beetles that spread the fungus. Biquinolin sulphate to kill fungus spores. Plant resistant species of elm. |
| White pine blister rust | *Cronartium ribicola* | White pine (also eastern white pine and sugar pine)<br>Gooseberry and currant (required alternate hosts) | Girdles stem, killing tree. | Removal of gooseberry and currant shrubs in the vicinity of pine. |
| Oak wilt | *Endoconidophora fagacearum* | Various oak species, Chinese chestnut, and others | Plugs up wood cells. Causes wilting of leaves. Produces a poison which kills tree. | Removal of diseased trees. |

covering the cut surface; otherwise a stub is left which can never be healed over but will serve as a continual menace, since it offers a pathway for disease and insects to reach the interior of the tree.

**Diseases of Trees.** A disease of a tree may result either from unfavorable conditions of the non-living environment, or may be caused by the attack of living organisms. Among the former are conditions of extreme cold or heat, unfavorable soil conditions such as high acidity, the presence of poisonous chemical substances, too much or too little water, lack of porosity, or the presence of lethal gases in the atmosphere, and so on. The causal living organisms of greatest importance are classed almost entirely among the group of the fungi and the viruses which seem to be increasing in number, but actually only because our knowledge of them is enlarging. Insects are not considered disease-inducing organisms, at least not in orthodox academic circles. The damage they cause is classed as an injury which, it is true, is often the primary cause of secondary fungous infections. In the above table are given a few of the important fungal diseases of trees.

**Insects Injurious to Trees.** The greatly increased communication between all parts of the world in recent years due to airplane travel especially has brought about the introduction of many insect pests and diseases new to the United States. An absolutely tight and effective barrier against the many diseases and pests in foreign countries is the aim of our government. Many of these are not serious in their own country, but after they are introduced here they are free from their natural enemies, and furthermore often find new species to attack which have not suffered before. Hence their destructiveness may be much greater than in their native land.

The gypsy moth, *Porthetria dispar,* is an example of the disastrous results of the entrance of a non-native species of insect into the United States. The eggs were brought from France to Medford, Mass., in 1869 by a French scientist who had conceived the idea of crossing this insect with silkworm moths in order to produce a hardy silkworm. Some of his gypsy moths escaped, and several years later the moth had increased to sufficient numbers to become conspicuous. At the present time this pest, which eats the leaves of most forest trees including the oaks, infests most of New England and the eastern part of New York State. It is estimated that the average yearly damage amounts to one and one half million dollars. The caterpillar stage, at which the feeding is done, can be easily identified by the pairs of blue and red dots down the back. Control is effectively accomplished by spraying with DDT which can be economically applied from an airplane.

The white pine weevil, *Pissodes strobi,* that attacks the terminal shoots chiefly of the white pine, but also Norway spruce, jack and other pines, and sometimes other conifers, causes considerable loss by killing the main leader of the tree. It does this by laying eggs in the bark of the young shoots. On hatching, the small white grubs feed on the living inner bark, boring downward and killing the shoot. In subsequent years a side shoot may replace the main leader, but this inevitably results in a bayonet form of the trunk which ruins the value of the tree for lumber and mars it from an ornamental point of view. Young plantations may be protected somewhat by removing and burning the infested shoots as they appear.

Among other destructive insects, especially notable are the birch-leaf skeletonizer or miner, *Buccalatrix canadensisella,* that attacks the leaves of gray, paper, yellow, and European white birch; tent caterpillars, *Malacosoma* sp., whose tents are commonly seen in the crotches of wild cherry and apple during May and June; cankerworms that appear especially in spring when the leaves are unfolding, but also in the fall. The latter are the larval stages of several species and can be controlled by DDT applied in a spray as soon as the eggs hatch.

**Fire Damage.** All the damage and loss from diseases, insects, hurricanes, ice, snow, and hail storms becomes dwarfed when it is compared with the tremendous losses caused by forest fires. Nineteen hundred forty-seven is considered an average year for forest damage in the United States. In this year 200,299 forest fires burned over 23,226,000 acres—an area the size of Indiana—causing tangible damage amounting to more than $55,000,000 to timber, farm homes, barns, towns, and school houses. Besides this, the killing of the young growth in the forests, many years on its way to making forest trees, destruction of the valuable humus on the forest floor, spoilage of the watersheds and recreation areas, and killing of wildlife can easily amount to double the direct loss from fire.

That fire fighting and fire prevention in our forests is a business of major importance, and everyone's business, the public is beginning to realize. More effective methods of fire fighting and a better organization of fire-fighting crews, new fire towers for points of observation, and increased means of telephonic communication in dangerous areas are continually being developed, not only by the forestry bureaus in the individual states, but by the Forest Service in the Federal government.

**Tree Breeding.** The breeding of plants or animals is defined as propagation for the purpose of their improvement. Trees can be bred so that their offspring will resist diseases or insect pests and also for other desirable qualities such as rapid growth, good form, large size, fine quality of wood, better fruit, and so on.

There are two methods of breeding: (1) by selection, in which the best trees are selected and propagated vegetatively, that is, by cuttings or by grafting; and (2) by sexual generation in which one tree is used as the male and another as the female. The flowers containing the sexual organs are deprived either of their stamens, the male organs, or of their pistils, the female organs, according to the sex required for the breeding. The missing sex is supplied by transferring it from another tree. In generative breeding, selection is also involved, for the parents having the desired character, such as disease resistance, are selected for making the "cross," as the process is called.

Many forest experiment stations are now breeding through selection, and specifications for "elite" trees have been published. Generative tree breeding, however, is being carried on in comparatively few places. The Eddy Tree Breeding Institute at Placerville, Calif., established in 1924, now a branch of the U.S. Forest Service, specializes in breeding pine. The grounds of the Institute contain 90 world species of pine, and 70 new hybrids have already been produced by generative breeding. Some of these hybrids show much promise in greatly increased rate of growth over that of their parents and are being tested in various plantations. The Lake States Forest Experiment Station at St. Paul, Minn., is concentrating on the breeding of spruce. The Northeastern Forest Experiment Station at Chestnut Hill, Pa., is carrying on breeding experiments with a variety of trees, notably birch, maple, poplar, and spruce. In Rutgers University at New Brunswick, N. J., holly is being bred for ornamental purposes. The Boyce Thompson Institute at

Yonkers, N. Y., is conducting extensive experimental work on larch breeding. The Connecticut Agricultural Experimental Station is breeding races and species of hemlock as well as continuing the work in chestnut breeding begun by the Brooklyn Botanic Garden in 1930. The latter is being done in an effort to restore the chestnut as a forest tree to eastern North America. The U.S.D.A. at Beltsville, Maryland, Horticultural Crops Research Branch, is carrying on a similar project. At Harvard University, the Maria Moors Cabot Foundation is breeding poplar and has succeeded in making a valuable cross of white and Himalayan pine. In Florida, under the direction of the Southern Forest Experiment Station, experiments have been going forward for some years which have for their objective the breeding of pines with a higher yield of resin. These are only a few of the institutions and projects in which sexual breeding or crossing is now in operation. There are many others in which selective breeding is being done.

As has been said, next to food, wood is perhaps our most important organic materials. Later on, its many uses will be discussed. Statistics show that we are now using half again more wood than we are growing. The breeding of better, faster-growing trees is therefore of the utmost significance to the welfare of the nation.

**Street and Shade Trees.** It is hardly necessary to state that a street bordered on each side with healthy, vigorous trees is infinitely more attractive than one without them. Moreover, trees provide shade and lower the temperature on hot sunny days. In addition, it should not be forgotten that the presence of beautiful trees results in much-increased property values. This is all true whether it is in the city, suburbs, town, village, roadside, or lawns surrounding a private home.

For their ideal growth and development on streets, trees should not be planted between the curb and the sidewalk unless there is a strip ten ft. in width. A narrow strip of two or three ft., as is sometimes seen, theoretically does not allow for healthy growth, or sometimes even survival. However, in many cities such as New York City trees which have grown for years along the street do not have more than a strip of two or three ft. and sometimes even less space than that is provided; yet they appear to be in a fairly healthy state. Nevertheless, if the houses are some distance from the sidewalk it is far better to plant in the space between the walk and the house. The larger area thus available for root growth will pay big dividends in increased vigor of the growing trees.

Street trees are often planted too close together. The ideal spacing for the larger-growing kinds is 50 or 60 ft. apart, for medium-sized trees 45 or 50 ft., and for small trees 40 or 50 ft. Several recent hurricanes in the eastern United States, resulting often in almost catastrophic losses, have focussed attention on the relation of street trees to the utility wires overhead. In many places, the overhead wires are being replaced by underground systems, so that the problem may eventually disappear in this way. The planting of smaller trees which will not interfere with such wires is now being advocated. At the same time more attention is also being given to the pruning of dead limbs and removal of trees with hollow trunks, to safeguard against future hurricane damage.

Trees for city planting should possess the following characteristics: ability to endure severe winters (this applies to the northern states); ability to withstand initial transplanting; tolerance of city dust, smoke, and gases; tolerance of poor soil; abundant shade; pleasing foliage and habit of growth; suitability of size (fair size but not enormous); suitability of root system (not filling drain pipes or raising sidewalks); freedom from "suckering," that is, production of young basal shoots; comparative freedom from litter, that is, objectionable casting of flowers, twigs, and messy fruits; freedom of flowers and fruits from objectionable odor; resistance to disease and insect attack; resistance of trunk and branches to breakage in storms. On the basis of these specifications one might select the following trees to serve as ideal street trees in almost any section of the United States. In the order of preference they are: Norway maple, *Acer platanoides;* gingko, *Gingko biloba* (male form); pin oak, *Quercus palustris;* and London planetree, *Platanus acerifolia.* These four species of trees have been selected because they fulfill all the requirements for an ideal tree. Furthermore, they are easy to obtain in any nursery. There are, however, many other kinds which can serve as street trees and give entirely satisfactory results.

For suburban sections somewhat removed from the city proper, the streets of smaller towns and villages, country roadsides, and lawns not restricted by all of the above factors which are so necessary to consider in the city, the variety of trees that may be planted is greatly increased. Since it is not a question of which will manage to survive, the species will then depend upon special features desired or not desired, such as growth, appearance, longevity, autumn coloration and so on. However, the particular section of the country and its climate and soil conditions must also be taken into consideration in selecting the kinds of trees.

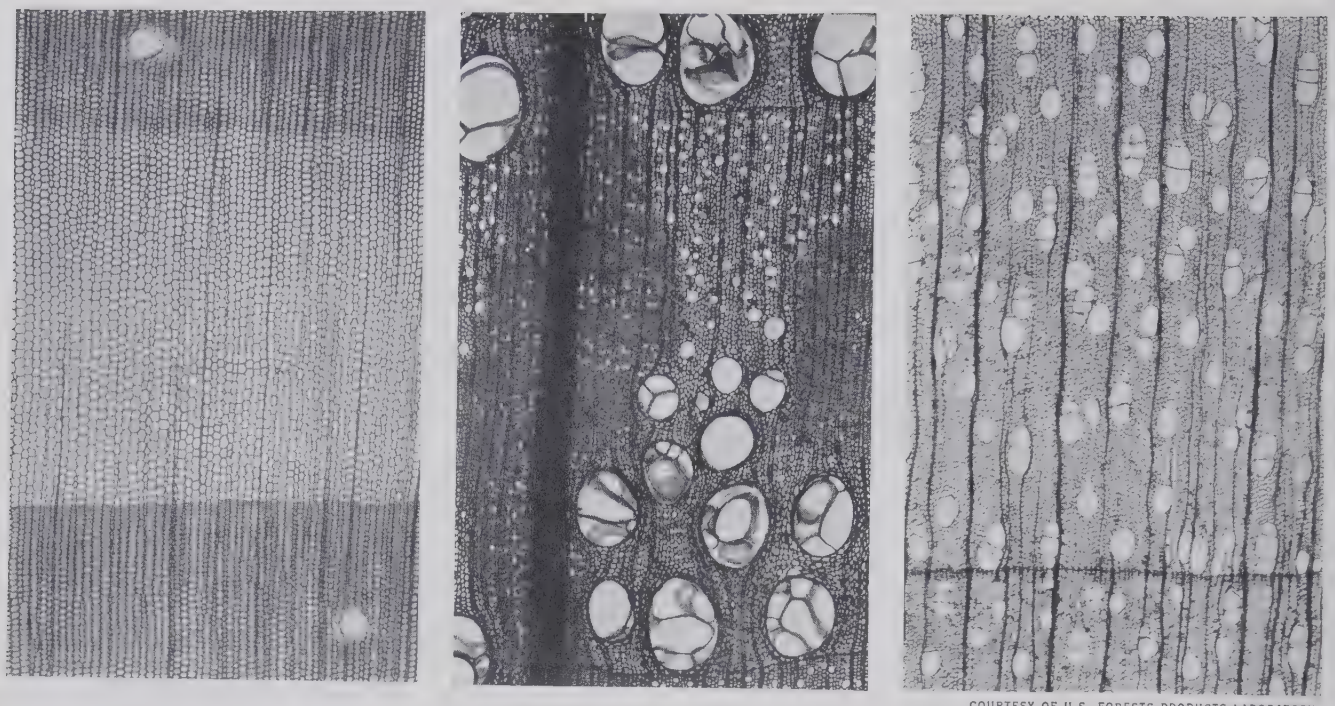
In the northeastern United States such trees as the sugar maple, elm, red, white and scarlet oak, tulip tree, sweet gum, American linden, European beech, honey locust, and hackberry can be considered good for general planting. Factors such as the brittle branches of the sugar maple and tulip tree may be important where there are many storms. On the other hand, others such as the longevity of the tree may be more important elsewhere in addition to attractive appearance and autumn coloration. The Dutch elm disease must be remembered in connection with the elm. However, there are areas free of this fungous disease where it is possible to plant it satisfactorily. Although not outstanding for most street plantings and as shade trees, evergreen conifers such as the eastern hemlock, red and white pine, white fir, and various species of spruce may be planted and achieve good growth, especially on lawns.

In the southwest, live oak, southern magnolia, camphor tree, willow oak, red maple, flowering dogwood, sweetgum, American holly, American beech, water oak, and cabbage palmetto are among those species which are good for street and shade plantings.

In the plains and prairies region, the soil is a very important factor and cultivation is often necessary after the trees have been planted. Good street and shade trees include the green ash, plains cottonwood, American elm, Siberian elm, hackberry, bur oak, tree-of-heaven, and Kentucky coffee tree.

Native trees are relatively rare in the Rocky Mountains section, but many have been planted. These include the black locust, box elder, Siberian elm, tree-of-heaven, green ash, linden, Norway maple, and also conifers. The first three are best able to survive with minimum care the climate and soil conditions of this section of the country.

The Pacific Coast may be divided into two sections, California and the North Pacific. In the former, the California live oak, southern magnolia, London planetree, sweetgum, and various conifers do well. In the North Pacific, the best



COURTESY OF U.S. FORESTS PRODUCTS LABORATORY

*Transverse sections, much enlarged, of three kinds of wood.* (Left) *shortleaf pine, with wood cells (tracheids), thin-walled in the springwood and thick-walled in the summerwood. Wood rays, one cell wide are seen also. The large openings are resin canals.* (Center) *white oak, a ring-porous wood with large spring vessels and both narrow and wide rays.* (Right) *yellow birch, a diffuse-porous wood.*

choice is among the hackberry, American yellow-wood, sweetgum, and various conifers.

## TREE PRODUCTS

**Wood.** Of all the materials and substances formed by plants, wood is without doubt the most useful and valuable to man, if the grains, tubers, fruits, nuts, and so on, used to nourish and sustain human life itself are excepted. It has been said that there are over 4,500 different uses of wood, but when the modern plastics and the multiplicity of their forms and uses are considered, this number could easily be greatly enlarged.

*Characteristics of Wood.* All woods are divided into two classes: (1) softwoods and (2) hardwoods. The former occur in cone-bearing trees such as pine, spruce, larch, and fir and contain in their structure, with rare exceptions, only one form of cell. The latter or so-called hardwoods are those of broadleaved trees such as the oak, birch, maple and basswood, and usually contain four kinds of cells in their structure. One of these kinds consists of vessels or ducts, the chief function of which is to carry up the sap from roots to leaves. If the vessels are arranged in rings as in the oak or ash, with one ring per year, the woods are called ring-porous; if the vessels are distributed more or less equally throughout the annual ring, being also often invisible to the naked eye, the woods are called diffuse-porous, such as in the birch, beech, and cherry.

This classification of all woods into hard and soft is rather misleading since there are many so-called softwoods that are hard, and vice versa. The problem arises from the fact that the classification depends upon the botanical characters of the trees and not strictly on the relative hardness or softness of their wood. There are some conifers known as softwoods such as the larch, hemlock, and red fir whose wood is actually hard. Some of the southern pines, as for example the longleaf pine, are hard and durable, being well impregnated with resin, and consequently are often used as construction timbers. The white oak is our most valuable hard wood. The most important and valuable conifers are the Douglas fir and white pine.

The lightest hardwood reported in the literature is the palo bobo de agua, *Aeschynomene hispida,* of Cuba which has an air-dry weight of 2.75 lb. per cu. ft. This species is actually little more than a shrub. The lightest wood available in what could be considered commercial size is quipo, *Cavanillesia platanifolia,* of Panama and Brazil. This species has an air-dry weight of 6.5 lb. per cu. ft. Balsa, *Ochroma* sp., of Ecuador and Central America is only slightly heavier, commonly weighing 7 to 9 lb. per cu. ft. when dry. It is undoubtedly the lightest hardwood in common use, and is readily available.

The heaviest wood on record is letterwood, *Piratinera guianensis,* from Surinam, which weighs 90 lb. per cu. ft. when air-dry. A close second is the black ironwood, *Krugiodendron ferreum,* of southern Florida, Cuba, and Central America. The heaviest well-known timber of commerce is lignum vitae, *Guaiacum* sp., of the West Indies which has a weight of 78 lb. per cu. ft. when air-dry.

The wood with the highest bending strength is kaneelhart, *Licaria cayennensis,* of Surinam and British Guiana. Expressed on the basis of the load that could be carried by a 2 by 2 in. beam mounted on a 28 in. span, this wood could support a load of 6,300 lb. at the center. A comparable beam of quipo could carry only a 250-lb. load.

The hardest wood on record is one that was tested a number of years ago at the University of Michigan. It is flor amarillo, *Tabebuia spectabilis,* of Venezuela. This wood has a side hardness of 4,120 lb. when tested air dry. This is the load required to embed a steel ball of 0.444 in. to a depth of one half of its diameter in the wood. At the other

extreme is balsa which has a side hardness of only 76 lb. when air dry.

*Lumber.* Lumber is the name for sawed timber, timber being the word for trees standing in the forest. Lumber is the most important use of wood. It is used principally in house construction, for sills, studs, flooring, laths, shingles, and trim, also sheathing, and for construction timbers in general. Railroad ties, cooperage, mine timbers, and utility poles make use of a large portion. It is also used in the manufacture of such items as boxes, crates, furniture, agricultural implements, boats, baseball bats, pencils, woodenware, caskets, automobile and truck bodies, musical instruments, tanks, and veneer. The various characteristics of different woods make certain species preferable to others in the manufacture of the products mentioned. For example, the woods of ash, Douglas fir, redwood, western red cedar, cypress, and tamarack are among those preferred for the construction of cross ties.

The highest grade veneer is made from the wood of black walnut, white oak, and exotic species such as mahogany, Spanish cedar, and rosewood. Others include Douglas fir, red gum, tulip tree, and ponderosa pine.

The important furniture woods are mahogany, maple, oak, walnut, birch, and fruit-woods. Mahogany is the world's finest cabinet wood. The Wesst Indies mahogany, *Swietenia mahagoni,* found in the West Indies and to some extent in Florida, is the most valuable timber tree in tropical America. Various cabinet woods including another mahogany, *Khaya* sp., come from the west coast of Africa. Brazilian rosewood, *Dalbergia nigra,* of tropical America, satinwood, *Chloroxylon swietenia,* of Ceylon and East Indies, and marblewood, *Diospyros marmorata,* of Andaman and Nickobar Islands, are among other important cabinet woods.

Teak, *Tectona grandis,* found in India, Indonesia, the Philippines, Burma, Malaya, and Thailand, is the most important timber tree in Southeast Asia. It is strong and durable and is superior to most other woods for shipbuilding.

In Australia, the eucalyptus is of economic importance as a timber tree. It is fast-growing, with very durable lumber used for general building purposes. The red-cedar, not a conifer, is a fine-grained wood, light, soft, easily worked, fragrant, and very durable when exposed to weather. It is valuable for cabinet work, panelling, and building of light boats.

Considerable amounts of lumber are finely ground and enter as "wood flour" into the composition of linoleum, explosives, and plastics. Another of the prime uses for wood is, of course, as fuel.

*Charcoal.* This product is made by heating wood and preventing its oxidation in charcoal kilns. It is practically pure carbon and is much used as a domestic and picnic fuel, is used in smelting and refining various ores, in making carbon disulphide, which is itself used in making viscose, rayon, and cellophane; it is also important in the preparation of sodium cyanide, a powerful disinfectant. Softwoods of willow, poplar, and maple are among the best woods for this purpose.

*Plywood.* Plywood is formed of sheets of veneer peeled off a section of trunk by special machinery. These thin layers of veneers of wood are bound or glued together by the use of the modern thermosetting resins and united under pressure into a firm bond. Such modern plywood is waterproof and resistant to decaying bacteria and fungi. It is said that plywood has greater strength per unit of weight than have the metals. Bodies of busses and of railroad cars and hulls of small boats make use of this strong, lightweight, all-weather material. Plywood panels are now in demand for buildings because of their large size and uniform strength. New techniques have released plywood from its original role as only a flat sheet material. Now it can be molded to form compound curves. Douglas fir and ponderosa pine are among the species of trees used in the manufacture of plywood.

*Laminated Wood.* Mention should be made of modern laminated wood. Briefly, this is the preparation of timbers which are to be subjected to stress such as large arches in building construction or even tennis racquets. It is made by firmly bonding strips of wood together under pressure, using the modern resin glues, the grains of the wood of different pieces running parallel. In plywood they are usually at right angles in successive plies. By this method of treating wood, defective sections of lumber can be eliminated and short dimensions, otherwise useless, can be pressed into service. Since much of our lumber is now from second growth which is often defective timber, the laminated process is of much economic importance.

*Source of Chemical Substances.* Chemically, wood is a carbohydrate, not very far in its composition from sugar and starch. It contains among other things a considerable amount of cellulose, and by chemical treatment this cellulose becomes the pulp used for paper and paper products. It is also used in the manufacture of rayon, cellophane, nitrocellulose, plastics, and many other important materials.

In many wood-utilizing processes, such as paper pulp manufacture, the lignins become separated from the cellulose as they are insoluble with acid used in these methods. Lignin consists roughly of a third of the chemical constituents of wood. Unused lignins when returned to the soil help to maintain it in a good physical condition. The lignins available from American pulp mills were estimated in 1949 at 3,500,000 tons a year. Recently many other uses have been found for this lignin residue. It is a source of vanillin and related compounds. It is also used as a dispersing agent for Portland cement, used in the negative plates of storage batteries, and for the production of tannins. It helps as a binder for foundry cores, is an ingredient in linoleum cement, and is used as a road surface binder.

By destructive distillation of wood, methyl or wood alcohol is obtained which is useful as an anti-freeze in automobile radiators, as a solvent in many industries, and for making formaldehyde, one of the principal ingredients in the manufacture of plastics. Other products are acetone, used as a solvent in the rayon and plastic industries, and acetic acid used in making white lead paint and acetate rayon and films.

When wood is hydrolyzed, that is, heated with a dilute solution of acid in water under moderate steam pressure, sugars are formed to the extent of about one half of the weight of the wood. These sugars, a mixture of glucose and several other forms of sugar, would be difficult to purify, but can be evaporated easily to a molasses that contains 50 per cent sugar. This molasses is being tested as an animal feed and preliminary results show that it is palatable to cattle and sheep. The sugar solution resulting from hydrolysis can also be fermented into grain or ethyl alcohol, useful for many industrial purposes. If, and when, petroleum products begin to fall, ethyl alcohol could become one of the most important motor fuels. At present it can be produced from wood at about one fifth of the cost of producing it from grain.

Among other chemical substances obtained from wood are turpentine and tar which are valuable in the preparation

FLAVORINGS AND MEDICINALS

| *Product* | *Tree* | *Country* | *Part Used* | *Use* |
|---|---|---|---|---|
| Balm of Gilead and Balsam poplar oil | Poplar (*Populus candicans* and *P. balsamifera*) | Northern United States, Canada | Buds | Stimulant, expectorant |
| Camphor Oil | Camphor (*Cinnamomum camphora*) | Asia, Malaya, China, Japan, United States | Wood and leaves | Salves, soap, perfumery |
| Cascara (powder) | Cascara (*Rhamus purshiana*) | Northwestern United States, adjacent Canada | Bark | Tonic, laxative |
| Cherry powder | Wild cherry (*Prunus serotina*) | Eastern United States | Bark | Expectorant, simple bitter |
| Cinnamon | Cinnamon tree (*Cinnamomum loureirii*) | India, Malaya, Ceylon | Bark | Aromatic, flavoring agent |
| Citric fruit oil | | | | |
| Orange Oil | Orange (*Citrus sinensis*) | India, United States, Italy, France | Fresh peel of ripe fruit | Flavoring, carminative |
| Lemon Oil | Lemon (*C. limon*) | Same as above | Same as above | Same as above |
| Oil of Bergamot | Bergamot (*C. bergamia*) | Southern Italy, France | Same as above | Perfumery, cosmetics |
| Clove Oil and Powder | Clove tree (*Eugenia caryophyllata*) | Java, Malaya, India, Madagascar | Flower Buds | Antiseptic, flavoring |
| Cocoa Powder and Butter | Cocoa (*Theobroma cacao*) | West Indies, South and Central America, Mexico | Ripe seeds | Nutrient beverage |
| Coconut Oil | Coconut Palm (*Cocos nucifera*) | Philippines, East Indies, Ceylon, tropical America, Africa | Kernels | Manufacture of soap, cosmetics, shampoo |
| Coffee | Coffee tree (*Coffea arabica* and other species) | South and Central America, West Indies, India | Seeds | Beverage, flavoring |
| Juniper (powder) | Juniper (*Juniperus communis*) | North America, Eurasia, North Africa | Dried ripe fruit | Stimulant, diuretic, flavoring |
| Kola (powder) | Kola (*Cola nitida*) | Africa | Seeds | Cerebral, cardiac, nerve stimulant |
| Mace | Nutmeg tree (*Myristica fragrans*) | East Indies, India | Dried seed attachment | Flavoring, pharmaceuticals |
| Nutmeg | Same as above | Same as above | Dried seed kernels | Same as above |
| Oil of Eucalyptus | Blue-gum (*Eucalyptus globulus*) | Australia, Tasmania | Dried leaves | Stomachic, carminative, expectorant, antiseptic |
| Oil of Wintergreen | Sweet birch (*Betula lenta*) | Eastern United States | Bark | Antirheumatic, flavoring |
| Olive Oil | Olive tree (*Olea europaea*) | Countries of the Levant | Ripe fruit | Nutritive, laxative, emollient |
| Palm Oil | Oil Palm (*Elaeis juineensis*) | West Africa | Fruit | Manufacture of soaps, candles, ointments |
| Papain | Papaya (*Carica papaya*) | Tropical America | Dried and purified latex from fruit | Protein digestant, meat tenderizer |
| Pomegranate powder | Pomegranate (*Punica granatum*) | India | Bark | Taenifuge |
| Quinine (powder or extract) | Quinine (*Chinchona succirubra*) | South America | Bark | Bitter tonic, antimalarial, antipyretic |
| Rosin | Longleaf pine (*Pinus palustris* and other species) | Southeastern North America | Bark | Salves, plasters, ointments |
| Santal Oil | Sandalwood (*Santalum album*) | India, Malaya | Dried heartwood | Perfumery |
| Sassafras (powder and oil) | Sassafras (*Sassafras albidum*) | Eastern United States | Bark of root | Aromatic, stimulant, diaphoretic, flavoring, beverage |
| Slippery Elm powder | Slippery Elm (*Ulmus rubra*) | Eastern United States | Inner bark | Demulcent, emollient |
| Tea | Tea (*Camellia sinensis*) | India, China, Japan | Leaves, leaf buds | Beverage |
| White pine powder | White Pine (*Pinus strobus*) | Eastern North America | Inner bark | Cough syrups |
| Witch-hazel (powder or extract) | Witch-hazel (*Hamamelis virginiana*) | Eastern United States | Leaves and twigs | Astringent, haemostatic |

of paints, in the manufacture of naval stores, and also in *materia medica*. Large quantities are obtained from pine wood, particularly southern kinds. Tannin used in leather manufacture is obtained by extraction from chestnut wood, hemlock bark, the bark and heartwood of quebracho, *Quebracho* sp., of Argentina and Paraguay, and the mangrove, *Rhizophora* sp., found in Florida, the West Indies, Mexico, Central America, and Brazil. Various dyes are obtained from trees. Osage orange furnishes a dye. An important dyewood, *pao brasil,* comes from Brazil, the dye giving a red, yellow, or orange color. Another much-used dye material, haematoxylin, is obtained from the heartwood of *Haematoxylon campechianum,* native and cultivated in tropical America. Catechu or cutch is a dye extracted from the tropical mangrove, *Ceriops* sp. The extract obtained may also be used as a tanning agent.

**Maple Sugar.** The sap of the sugar maple, *Acer saccharum,* contains a considerable amount of sugar with a characteristically delicious flavor that is highly prized and immensely popular. The production of the syrup and sugar is carried on mostly in New England and adjacent Canada, and the states of New York, Pennsylvania, Ohio, Maryland, and the Great Lakes states. The sugar maple tree has the largest amount of sugar in its sap, while the red and silver maple yield about one half the amount. Butternut and the sweet birch are also a source. The sap flows in early spring, generally from about February 15 to April 15. The details of the process are briefly as follows: starch stored in certain tissues of the sapwood the previous year is changed by an enzyme into sugar which then enters in solution into the sap and is transported to the unfolding buds. Part of this can be drawn off without injury to the tree by small tubes or pipes inserted into the sapwood. The sap is collected from various trees and boiled down either to syrup or, further, to sugar.

**Christmas Trees.** The industry amounts to 20-25 million dollars per year, according to whether wholesale or retail prices are figured. The most popular tree is the balsam fir of the northeast, but spruce, red fir, and even pine and redcedar are common and nearly all kinds of conifers are used. The balsam fir and red fir are preferable because they hold their needles longer under house conditions. The Christmas tree trade is profitable. In many parts of the country, plantations have been made for this purpose alone; also plantations designed for future timber yield are thinned to supply Christmas trees. Six to ten years are required to grow a fair-sized tree. A grower of Christmas trees in New York State harvested 600 trees annually from a 15 acre tract and over a 15-year period grossed $7,000 in a combination retail and wholesale business.

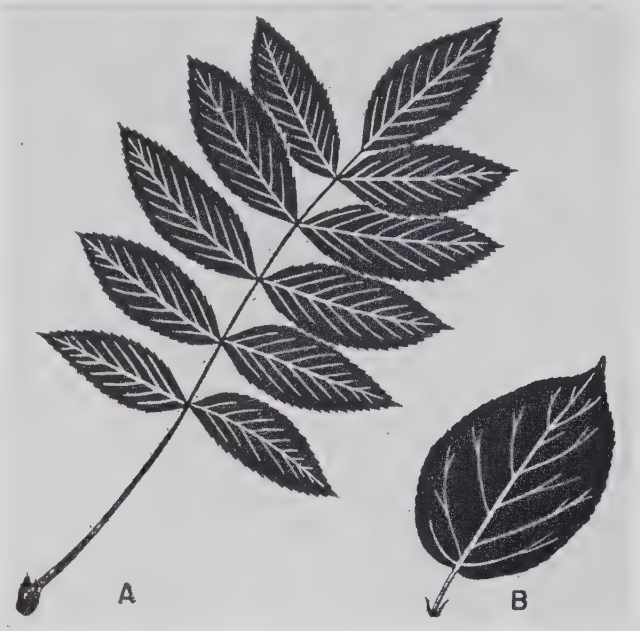
**Cork.** As the branches and trunk of a tree become older, a layer of cork forms in the inner bark which is the product of a cork cambium. The walls of the cork cells are impregnated with a waxy substance called suberin, which renders them impervious to moisture. As the outer bark sloughs off, new layers are formed from deeper cells.

The most important cork in commerce is that of the cork oak of Spain, *Quercus suber,* which produces an excessive amount. Most of the world's supply comes from that country. However, large trees of the cork oak in southern California yield considerable quantities of cork. Plantings are now made annually in 25 states in the warmer parts of the United States. The tree will not endure the cold of the northern parts of the country. Large sheets of cork several inches thick can be stripped from this tree. Trees are stripped every eight to ten years beginning at about the age of 20 years. Such treatment does not injure the tree; on the contrary, there is evidence that it stimulates the cork cambium to new production.

Cork has important industrial uses because of its lightness and the fact that it is air tight and impervious to water. It has been used for many purposes for more than 2,000 years. In addition to the yield of cork, the cork oak produces good crops of edible acorns which in Europe are used as a supplemental stock feed. In Portugal alone, about 200,000 lb. of cork oak acorns are gathered annually.

**Paper.** Since World War II the paper and paper board industry in the United States has annually manufactured products worth about 2.5 billion dollars. Paper of all kinds including newspapers, books, writing tissue, building paper, and paper board for cartons and containers are the main products. The chief raw material is, of course, wood pulp, which together with rosin, a residue in turpentine production, forms more than 80 per cent of all materials involved in paper making. The paper pulp consists almost entirely of the cellulose in wood, the lignin being separated in the chemical treatment. Only small quantities of linen and other cloth rags are now used in paper making, the reverse of conditions 150 years ago when little if any paper was made of wood.

**Rubber.** A tree product which has proved of immense value to man is rubber and although much of the rubber in our automobile tires is now synthetic, natural rubber still

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*Simple and compound leaves. (A) Compound leaf with opposite leaflets; (B) simple leaf. Both with serrate margins.*

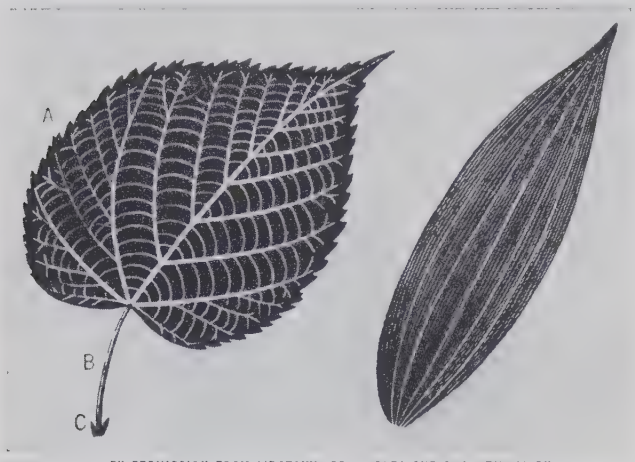
has a vast multitude of uses. Rubber comes from the milky sap known as latex of a variety of trees, chief of which is *Hevea brasiliensis.* These trees are distributed throughout the whole Amazon region, in Brazil, Colombia, Peru, and Bolivia. Much of our rubber, however, comes from the East Indies now, because large plantations of the Brazilian trees were begun there toward the close of the last century. The world's supply of natural rubber has been derived from these eastern plantations since about 1914. The India rubber fig, *Ficus elastica,* a native of tropical Asia, has a milky latex and was once a source of rubber.

**Chicle.** Another latex product which has attained importance during the last half century is chicle, which forms the base of most of the "chewing gum." It comes from a tree known as the sapodilla, *Achras zapota,* of Central America. In the last prewar year the retail "chewing gum" business amounted to $140,000,000.

**Wax.** The leaf buds of the Brazilian wax palm, *Copernica cerifera,* exude a waxy substance known as carnauba wax, an ingredient of many well-known wax preparations. The South American palm, *Ceroxylon* sp., similarly supplies a palm wax used in pharmaceutical preparations.

**Food.** The nuts and fruits of many trees, too numerous to mention, furnish food for man and for wild life. Prominent among these are Brazil nuts, cashews, coconuts, walnuts, hickory nuts, chestnuts, and fruits such as apples, pears, oranges, lemons, papayas, cherimoyas, and mangoes. Chest-

nuts, for example, have furnished a staple in the Italian diet for centuries. Chestnut flour is used in Italy to make bread. Now, with the chestnut blight threatening to wipe out all European chestnuts, the experiment stations are breeding the tree with more resistant species, as is being done in the United States.

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*Leaf venation.* (Left) *netted-veined leaf;* (right) *parallel-veined leaf with smooth margin.*

**Medicinals and Flavorings.** A chart is given (*See* p. 658N of some of the important substances used as flavorings or medicinals which are obtained from the leaves, fruit, bark, roots, or wood of various species of trees.

## IDENTIFICATION OF TREES

The identification of trees is based upon their general appearance and the characteristic features of their leaves, bark, winter buds, flowers, and fruit. Trees may be separated into two main groups for ease of identification: (1) the conifers and their relatives which bear cones and have either needle or needle-like leaves or scale-like leaves; (2) the broadleaf trees.

The general appearance or form of a tree such as an oak, maple, linden, or locust is a characteristic feature, and with practice one can recognize the species at a considerable distance by this alone. Familiar examples are young pin oaks with their typical drooping lower branches; tupelo with its peculiar right-angle branching; tulip tree with a tall, erect trunk which often divides at a wide angle. The kind of growth depends primarily upon the position of the buds. A true terminal bud results in an erect trunk as in the pine, spruce, tulip tree, hickory, and maple. A false terminal bud, actually a lateral bud where the apex of the shoot habitually dies, is apt to result in a more spreading branch system, as in the American elm.

The leaves of a tree are most important for use in its identification. Their appearance is generally characteristic of a species. For example, one might compare the leaves of the maple, the elm, and the pine. The needle-type leaves vary mainly in length, thickness, and shape, according to whether they are rounded or flattened along their length. In pines, they grow in clusters, and the number in a cluster is a constant feature for a species. The position of the broad-leaf-type on the stem is important. The leaves may be paired, that is, opposite each other, single and alternately arranged, or single and whorled on the stem. The leaf may be simple or divided into leaflets which may be pinnately arranged, that is, attached along each side of the rachis or axis of the leaf, as in the black locust or palmately arranged, that is, radiating from one central point of the leaf, as in the horse chestnut. The leaves or their leaflets may vary in shape, size, texture, margin, and venation. The venation or system of veins in the leaf is netted in the group known as the dicotyledons such as the maple or oak and parallel in the monocotyledons such as a palm. It is interesting to observe in the gingko, a very primitive relative of the conifers with a broad leaf, that the venation is forked or dichotomous as is usually found in ferns, but never in the more advanced plants. The size of the leaf may vary from the minute scale-leaf of a cypress to the large leaf of a palm tree. The texture of the leaf will vary from smooth to rough, waxy, or hairy. The margins of the leaf may be described as entire (smooth), serrate (sharp-toothed), dentate (large-toothed), and so on. The thickness of the leaf will vary with the species. The leaves may be deciduous (leaves shed every year) or evergreen.

The formation and color of the outer bark are of importance as identifying characters. However, both vary according to the age of the tree; in young stages the outer bark is smooth, and the color may differ from that of older bark. Since there is such variation some study of the bark of the different kinds and ages of trees is necessary. The color of the bark may be striped white and black, gray, white, black, or green depending upon the species of tree.

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*Cherry twig in summer condition (A) and winter condition (B). The leaves (and buds) are alternately arranged on the stem.*

The bark may be smooth but usually the segments of outer bark slough off, the shape of the segments depending on the kind of tree. The bark may be flaked, shaggy, ridged, or striped. In the shagbark hickory, the segments are in large plates; in the pignut hickory, in smaller scales. In the hop-hornbeam, the outer bark exfoliates in long, irregular, more or less vertical, ragged strips; in the hornbeam the bark does not exfoliate at all and is smooth, but fluted, showing as it were "muscular ridges." The sycamore sheds its bark in curved segments, showing white patches of inner bark beneath. The London plane, a related species, sheds its

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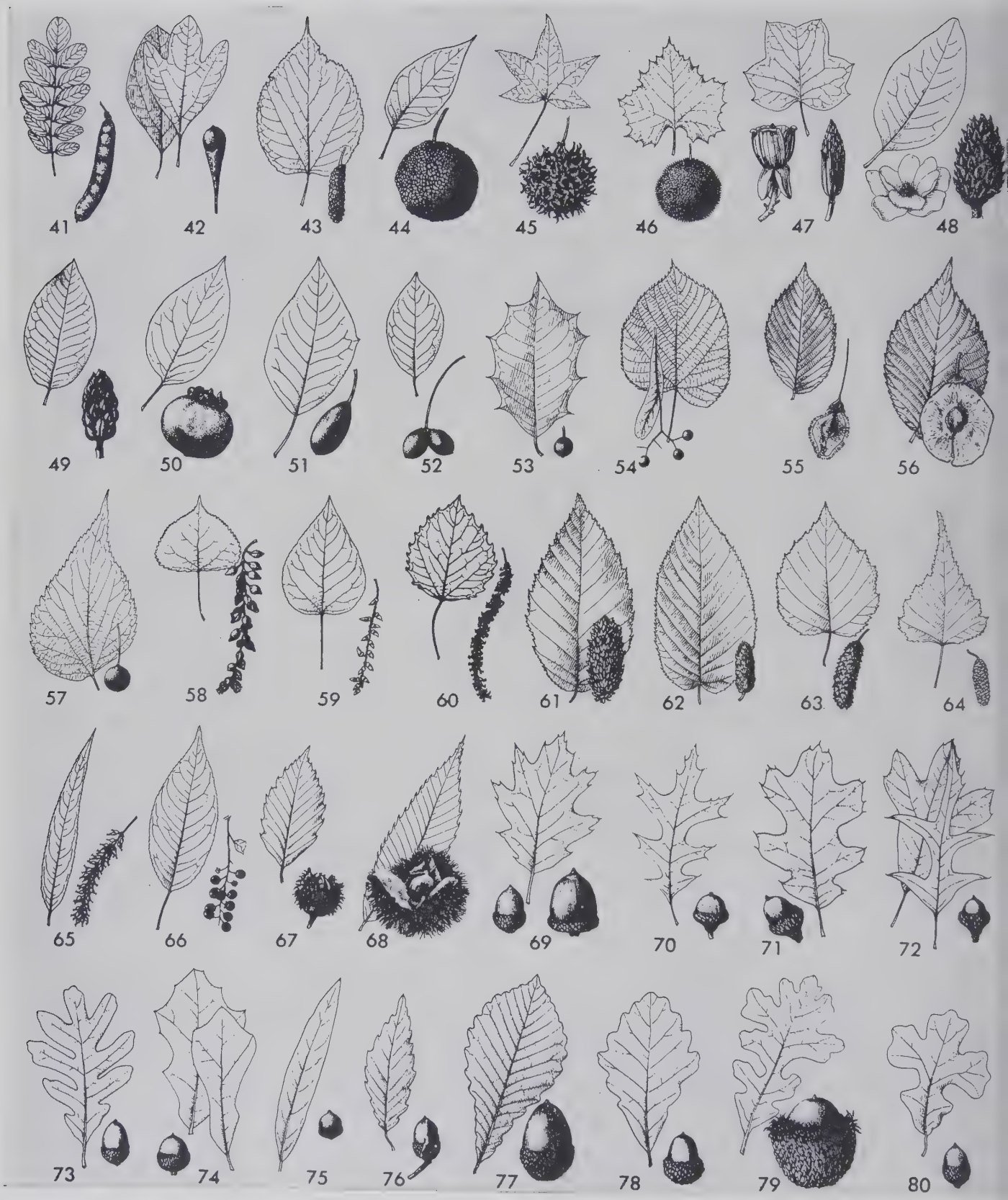
*Trees native to North America: (1) bald cypress; (2) pond cypress; (3) American larch; (4) eastern white pine; (5) longleaf pine; (6) slash pine; (7) pitch pine; (8) shortleaf pine; (9) loblolly pine; (10) red pine; (11) jack pine; (12) eastern hemlock; (13) red spruce; (14) white spruce; (15) black spruce; (16) balsam fir; (17) northern white-cedar; (18) Atlantic white-cedar; (19) eastern red-cedar; (20) southern red-cedar; (21) cabbage palmetto; (22) northern catalpa; (23) flowering dogwood; (24) white ash; (25) sugar maple; (26) black maple; (27) silver maple; (28) red maple; (29) box-elder; (30) red ash; (31) black ash; (32) yellow buckeye; (33) Ohio buckeye; (34) black walnut; (35) butternut; (36) pecan; (37) bitternut hickory; (38) shagbark hickory; (39) pignut hickory; (40) honey-locust.*

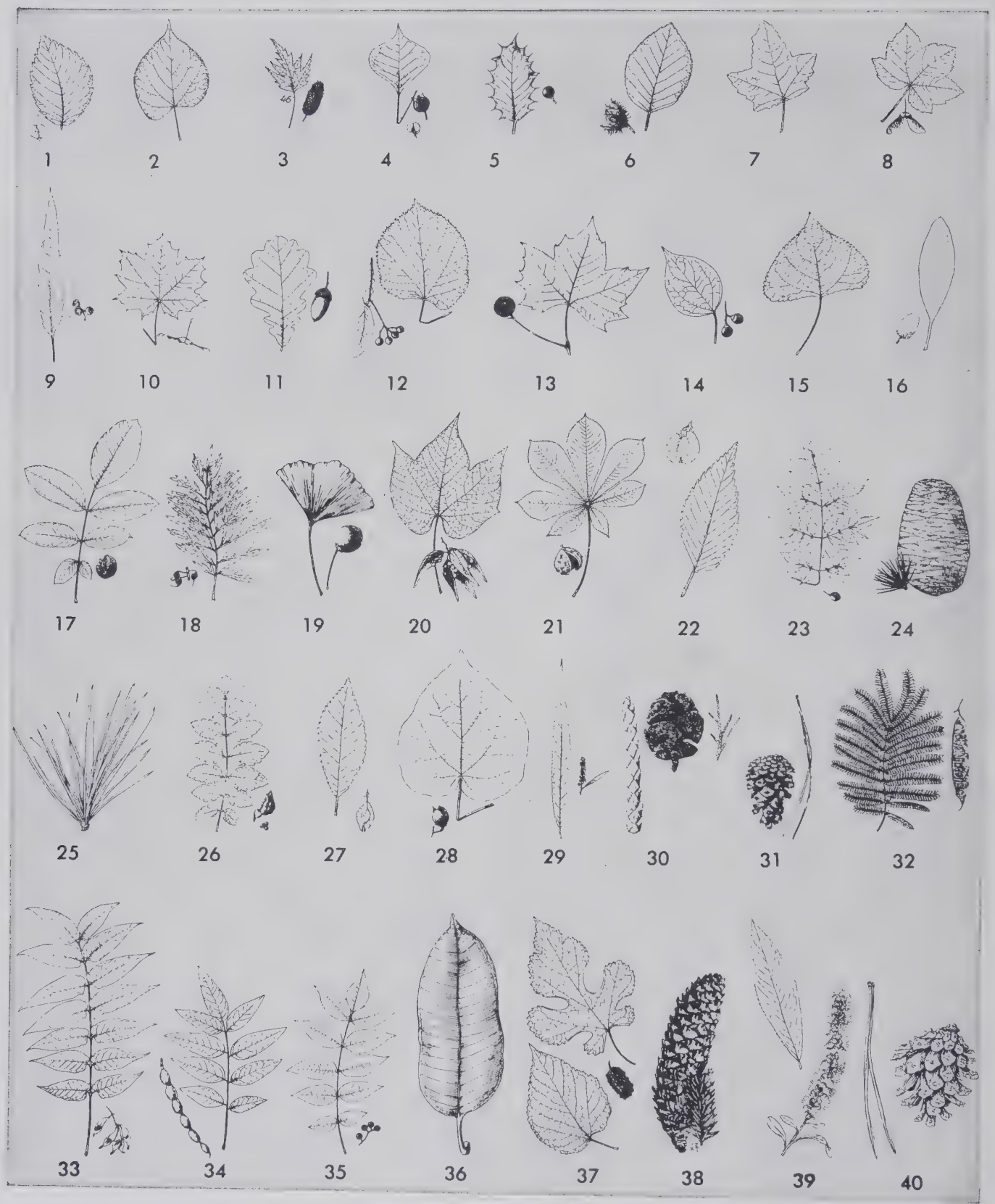



COURTESY OF THE U.S. DEPT. OF AGRICULTURE

*Trees native to North America: (41) black locust; (42) sassafras; (43) red mulberry; (44) osage-orange; (45) sweet-gum; (46) American sycamore; (47) tulip tree; (48) southern magnolia; (49) cucumber-tree; (50) common persimmon; (51) water tupelo; (52) black gum; (53) American holly; (54) American basswood; (55) American elm; (56) slippery elm; (57) hackberry; (58) eastern cottonwood; (59) balsam poplar; (60) bigtooth aspen; (61) yellow birch; (62) sweet birch; (63) paper birch; (64) gray birch; (65) black willow; (66) black cherry; (67) beech; (68) chestnut; (69) northern red oak; (70) pin oak; (71) black oak; (72) southern red oak; (73) white oak; (74) water oak; (75) willow oak; (76) chinkapin oak; (77) swamp chestnut oak; (78) swamp white oak; (79) bur oak; (80) post oak.*

COURTESY OF THE U.S. DEPT. OF AGRICULTURE

*Trees native to North America: (81) western larch; (82) pinyon pine; (83) limber pine; (84) lodgepole pine; (85) ponderosa pine; (86) Jeffrey pine; (87) western white pine; (88) Pacific yew; (89) sugar pine; (90) western hemlock; (91) blue spruce; (92) sitka pine; (93) white fir; (94) grand fir; (95) redwood; (96) California red fir; (97) Engelmann spruce; (98) Douglas-fir; (99) noble fir; (100) giant sequoia; (101) incense-cedar; (102) western red-cedar; (103) Alaska-cedar; (104) Arizona cypress; (105) Rocky Mountain juniper; (106) western juniper; (107) Pacific dogwood; (108) bigleaf maple; (109) Oregon ash; (110) quaking aspen; (111) plains cottonwood; (112) black cottonwood; (113) red alder; (114) cascara buckthorn; (115) Pacific madrone; (116) golden chinkapin; (117) California black oak; (118) Oregon white oak; (119) California white oak; (120) gambel oak.*




COURTESY OF THE U.S. DEPT. OF AGRICULTURE

*Trees from foreign lands: (1) English elm; (2) European linden; (3) European white birch; (4) tallow tree; (5) English holly; (6) European beech; (7) white poplar; (8) planetree maple; (9) longbeak eucalyptus; (10) Norway maple; (11) English oak; (12) silver linden; (13) London planetree; (14) camphor tree; (15) Lombardy poplar; (16) Russian olive; (17) Persian walnut; (18) silk oak; (19) ginkgo; (20) Chinese parasol tree; (21) horse chestnut; (22) Siberian elm; (23) Chinaberry; (24) cedar-of-Lebanon; (25) deodar cedar; (26) panicled goldenrain-tree; (27) Chinese elm; (28) royal paulownia; (29) weeping willow; (30) Italian cypress; (31) Austrian pine; (32) silktree; (33) ailanthus; (34) Chinese scholar tree; (35) Amur corktree; (36) India rubber fig; (37) white mulberry; (38) Norway spruce; (39) white willow; (40) Scotch pine.*

outer bark in a similar way, but the inner bark thus exposed is a greenish-yellow.

The lenticels in the bark (raised dots or horizontal lines, marking openings for gaseous exchange) are a characteristic feature in some species. They are especially prominent in various kinds of cherry and birch.

The winter buds of each species are distinct and vary in size, shape, and in the type of scale covering. Their color varies with the species. The buds may be gray, black, reddish, or green. They are shiny or dull, smooth or hairy. Some trees have embryo flowers and leaves in the same bud; in others there are special flower buds which become a distinguishing feature as in the dogwood.

The flowers of the tree can be good identifying characters for a short period, and likewise the fruit. In some trees, such as the sycamore, the fruits may remain on the tree almost all year round. The cones of the conifers like the fruits of other trees may be used for identification.

On the previous pages are small sketches of the leaves and fruit of some of the most important trees found in North America. Nos. 1-120 are native to North America. They are in two series: Nos. 1-80 are native to the eastern part of the continent, and Nos. 81-120 are native to the western half. The last page of illustrations covers some of the trees originally introduced from foreign lands but now found widely cultivated and as escaped forms in the United States and Canada. *See also* Conifer; Flowering Plants; Forestry; National Forests; Plant Anatomy; Wood.

A. H. Gr. and E. P.S.

**TREE CAT.** *See* Paradoxure.

**TREE DUCK,** any one of eight species of duck-like birds of the genus *Dendrocygna,* apparently most nearly related to the geese and swans. They occur in tropical regions around the world and in some parts of the temperate zones. Tree ducks, or whistlers, are characterized by long necks, long legs, and feet that enable them to perch on trees, although few of them ever do this. Their plumage is a combination of browns, grays, chestnut, black, and white. The black-bellied tree duck, *D. autumnalis,* is found in southern Texas, while the fulvous tree duck, *D. bicolor,* occurs in the southwestern states from Louisiana to California.

H. G. De.

**TREE FERN,** a name given to ferns belonging to the tree fern family, Cyatheaceae, native to warm regions in both hemispheres. They have a treelike trunk or caudex, in some species tall and slender, in others rather stout. At the top of the trunk is a rosette of large, graceful, finely cut leaves, sometimes 10 ft. long. They often reach 15 to 30 ft. in height, some species of the genus *Cyathea* exceeding 50 ft. They are a beautiful feature of the tropical vegetation and several are valued as conservatory plants. Among the best-known tree ferns are various species of the genera *Alsophila, Cibotium, Cyathea,* and *Dicksonia.* G. M. Sm.

**TREE MALLOW,** common name for various woody species of *Lavatera,* a genus of the mallow family. The California mallow, *L. assurgentiflora,* is a shrub growing to 15 ft. in height. It has purple flowers about 3 in. across, and is planted in mild climates. *L. arborea,* is native to rocky seacoasts of Europe, and is also cultivated as an ornamental plant because of its purple flowers and fine foliage.

J. C. Wis.

**TREE ORCHID,** *Epidendrum,* a genus of orchids growing on trees in the southeastern United States and in tropical America. There are several hundred species, about eight of which grow in the Florida hammocks and southward along the Keys. One, the green-fly orchid, *E. conopseum,* is found on live oak and magnolia as far north as South Carolina. The North American varieties are generally small, having linear or lanceolate leaves, and white or greenish flowers. In the tropics, the plants attain a larger size and more brilliant coloring, such as *E. vitellinum,* a native of Mexico and Guatemala. This orchid is one of the few species introduced into cultivation. Many other genera of orchids, however, live on trees, such as *Vanda, Dendrobium, Cymbidium,* and *Cattleya.*

J. C. Wis.

**TREE SHREW,** a squirrel-like mammal of the family Tupaiidae, combining anatomical resemblances to both primates and insectivores. The teeth resemble those of certain lemurs, and the eye socket is surrounded by a bony ring. The feet are five-toed and clawed. The muzzle is long and pointed. Tree shrews are diurnal and eat insects, eggs, fruit, and buds. Common tree shrews, *Tupaia,* of India and the Malay region, have bushy tails and are usually brownish or olive-brown. Slender-tailed forms, *Dendrogale,* are found in Indo-China and Borneo, while a similar type, *Urogale,* lives in Mindanao. Another genus, *Ptilocercus,* is characterized by a long tufted tail; it is grayish with a dark facial mask; its teeth are especially primitive. This pentailed tree shrew occurs in Sumatra, Borneo, and Palawan, as well as on the Malay Peninsula. *See also* Insectivore; Primates. J. E. Hi.

**TREE TOAD** or **TREE FROG,** any of the small toad-like or froglike arboreal amphibians belonging to the family Hylidae. They have long legs ending in digits provided with adhesive disks, by which they cling to objects. World-wide in distribution, except for the polar regions, Africa, Madagascar, and Indo-Malaya, the greatest diversity occurs in the tropical forests of South America. Often called "acrobats of the frog world," they delight in long leaps among the tree branches, and sometimes land clinging precariously by one foot. They then pull themselves up and settle into a comfortably concealed position, their colors blending remarkably with those of the tree bark. This body color changes under different conditions, usually becoming darker in cool, moist places. The loud, trilling calls of these amphibians are frequent during damp weather or before storms; hence they are often called weather prophets. They are most active during the evening and at night, when they pursue insects for food. A. Sv.

**TREHALOSE.** *See* Sugar Chemistry (*Oligosaccharides*).

**TREITSCHKE, HEINRICH GOTTHARD VON** [trai'tshkə] (1834-1896), German historian, was born in Dresden, Sept. 15, 1834, the son of a Saxon army officer. He studied at the universities of Leipzig and Bonn, and in 1858 joined the faculty of the University of Leipzig. At about this time Treitschke became an ardent liberal and in 1863 accepted a call to lecture at Freiburg. During the German civil war (1866), he became a Prussian subject and professor at the University of Kiel. He taught also at Heidelberg in 1867, and in 1874 became professor of history at Berlin. In 1871 Treitschke was elected as a National Liberal to the first Reichstag of the German Empire, abandoned the National Liberal party in 1879, and remained a Moderate Conservative member of the Reichstag until 1884. Actually, Treitschke was by now anything but moderate, being anti-Catholic, anti-Semitic, and anti-British. He became the great interpreter of the aggressive Prussian spirit and the expanding power of the Bismarckian empire, overseas as well as in Europe. His most brilliant piece of historical writing was

entitled *Deutsche Geschichte im neunzehnten Jahrhundert* (5 vol., 1879-1894; English translation *German History in the Nineteenth Century,* 7 vol., 1915-1919). Other works of Treitschke's were *Historische und politische Aufsätze* (1865, 1870, 1897); *Zehn Jahre deutscher Kämpfe* (1874; 3rd ed., 1897); and *Politik* (2 vol., 1907). In 1866 he became the editor of the *Preussische Jahrbücher,* and in 1895, upon the death of Heinrich von Sybel, editor of the *Historische Zeitschrift.* Treitschke died in Berlin, Apr. 28, 1896.
R. H. L.

**TRELAWNY, EDWARD JOHN** [trəlɔ'ni] (1792-1881), English adventurer and author, best known through his association with Shelley and Byron, was born in London Nov. 13, 1792, the son of an army officer. After attending naval school, the youth shipped out to India, where, deserting the service, he remained for several years. His friendship with the two poets began in 1822 at Pisa and lasted until their deaths. When Shelley was drowned at sea in July 1822, Trelawny recovered his body and later snatched his heart from the flames during the ceremony of cremation. He accompanied Byron to Greece in 1823, but left him for immediate combat under the Greek insurgent leader, Odysseus Androutsos. During the next decade Trelawny lived in Paris and Florence, was briefly lionized in London, where his romantic connections and his own personality attracted a wide circle, and visited the United States. He was married four times: to an Arabian girl; to Julia Addison, an Englishwoman; to Terzitza Kamenou, sister of Odysseus Androutsos; and in 1847 to Lady Vane Goring. Trelawny's works include his autobiography, *Adventures of a Younger Son* (1831), and his *Recollections of the Last Days of Shelley and Byron* (1858; in 1878 retitled *Records of Shelley, Byron, and the Author*). He died Aug. 13, 1881, at Sompting, near Worthington, West Sussex, England. H. M. J.

**TREMATODA.** *See* Animal Systematics; Flatworms; Flukes.

**TREMOLITE.** *See* Amphibole Group.

**TREMOLO** [trɛ'molo], a term in music always meaning a trembling or fluttering of tone, but produced by different technical means on various instruments.

On violins and other string instruments which are played with a bow two kinds of tremolo are achieved: the bowed tremolo, produced by rapid, up-and-down agitation of the bow on a single note; and the fingered tremolo, a rapid alternation of two different tones produced by the finger on a single string while the bow draws a steady tone from that string.

The vocal tremolo corresponds not to the string tremolo but to the string vibrato; it is a more or less rapid wavering of pitch both above and below the tone nominally being sung. Though often appropriate, when tastefully executed, as a means of "coloring" a straight tone, it is much overdone and is the hallmark of the mediocre singer, who uses it either because he cannot control his vocal chords or else because he wishes to disguise poor tonal quality by this means. The acceptance of this form of tremolo among first-rate singers dates only from the early nineteenth century; the true vocal tremolo, a rapid reiteration of a single tone, was common in earlier periods, but died out, practically speaking, in the eighteenth century. The yodel, it might be noted, is the vocal equivalent of the violinist's fingered tremolo.

On pianos and other keyboard instruments, a rapid alternation of different notes of a chord serves as a tremolo and is almost always found in piano arrangements of orchestral scores to indicate orchestral background. On mandolins, xylophones, balalaikas, drums, and certain other instruments, tremolos, called "rolls" on the drum and produced by rapid reiteration of single tones, act as sustained tones. W. Li.

**TRENCH FEVER.** *See* Rickettsia.

**TRENCH MOUTH.** *See* Mouth Diseases.

**TRENT,** the third longest river in England. Rising on the southwestern slopes of the Pennines and the border of the Cheshire plain, it flows southward to the moorland range and drains the central plains, from Severn Valley to the upland range of Rockingham Forest, in a northeasterly direction. It joins the Yorkshire Ouse to form the Humber, which empties into the North Sea. The Trent is navigable 95 mi. above its junction with the Ouse and is connected by a system of canals to other waterways of middle and western England. Beds of gypsum give its waters a hardness prized by breweries. Burton, Nottingham, and Newark are located on this meandering river. S. Van V.

**TRENT, COUNCIL OF.** *See* Council of Trent.

**TRENT AFFAIR.** *See* Civil War.

**TRENTINO-ALTO ADIGE** [trenti'no ɑ'lto ɑ'dije], formerly Venezia Tridentina, the northernmost region of Italy, which comprises the provinces of Trenton (Trentino) and Bolzano (Alto Adige), having an area of 5,250 sq. mi. It is bounded on the north by Austria, on the west by Switzerland and the region of Lombardy, and on the south by the region of Veneto. The Germans refer to it as the Südtirol.

The region has a certain geographical unity in that it lies almost wholly within the mountainous part of the Adige River watershed. Roughly in the form of a triangle, Trentino-Alto Adige is confined, on the north, by the crest of the Alps; on the east, by the Dolomites; and, to the west, by the massifs of Ortles and Adamello. The southern corner of this triangle extends to the Adige gorge above Verona. The region thus consists entirely of mountains and intermountain valleys. The only areas of level terrain are found in the latter, the largest being at the confluence of the Adige and Isarco valleys near Bolzano.

The Alpine chain marking the northern frontier has a number of peaks exceeding 12,000 ft. in altitude, and is pierced by only two practicable passes: the Brenner and the Resia. The Dolomites are not quite so high but are in several respects even more spectacular. A few glaciers are found in the mountains to the northwest, and much of the terrain everywhere is the result of glacial action.

The Adige River rises near the Resia Pass in the northwest corner of the region and proceeds in a generally easterly direction to Merano, where it turns southward. This upper part of its valley is called the Val Venosta. Near Bolzano, the Isarco joins it, after having picked up the waters of the Rienza (which flows through the Val Pusteria) at Fortezza (Franzensteste). Below Bolzano the principal lateral valleys are those of the Noce and Avisio rivers. The northern tip of Lake Garda and the headwaters of the Mincio basin (Sarca River) lie in the southwest part of the region.

The climate varies widely, depending on altitude and location. The Alpine rampart deflects many of the coldest winds of winter, while in some of the valleys, particularly in those facing south, the springs and autumns are warm and the summers hot. The warm, dry foehn winds are not unknown in the north. Rainfall likewise varies from around 20 in. in the Val Venosta to 28 in. around Bolzano, and over

40 in. in the eastern Alto Adige. In the Dolomites, an annual precipitation of 60 in. is not uncommon.

**The People.** Taken as a whole, the region is predominantly Italian-speaking, while in the Alto Adige all but about 12 per cent are German-speaking. A remnant of a once fairly extensive Latin-speaking element is found in the Dolomites. Illiteracy is practically nonexistent.

About three quarters of the people live in cities and villages, the rest in scattered dwellings. The chief urban centers lie along the trans-Alpine routes up the Adige and over the Resia and Brenner passes: Rovereto (20,758), Trento (62,611), Bolzano (73,652), Merano (25,902), and Bressanone (10,576).

**Economic Life.** The use to which the land in the region is put is indicated by the following percentages: woodlands, 43; pastures and meadows, 33; sown crops, 6; vineyards, orchards, and other such cultivation, 1½; not cultivated or unproductive, 15½. The principal crops, grown mostly in the valleys or on lower slopes, are wheat, corn, rye, potatoes, vegetables, fruits, and hay.

The forests tend to be coniferous in the north and deciduous in the south. The lumber from them is used for, among other things, the making of furniture in several towns of the region. Mineral deposits are varied but not important. Zinc, lead, copper, and iron are found in small quantities, as well as several lesser minerals. During the 1930's, the Fascist government expanded the area's metallurgical industries, notably at Bolzano.

Industrial development was rapid under the impulse of the Italian government after World War I, and was especially notable in chemicals, aluminum, and metal goods. A few textile plants are found here and there; and, in the mountain valleys, some of the ancient handicrafts survive.

Water power is abundant and is increasingly being harnessed to produce electricity for the railways, for industrial use, and for domestic consumption. The tourist industry, one of the region's economic mainstays, caters annually to several hundred thousand visitors. There are a number of mountain roads famous for their beauty, and the region is served by the main railway line from Italy through the Brenner Pass to Germany, and by several branches.

R. G. W.

**TRENTO** [tre'nto], the name of a provincial capital, known in English as Trent, and a province, in northern Italy.

**The City.** The city of Trento is situated in a narrow plain along the east bank of the Adige River at an elevation of 605 ft. above sea level and thus lies along the historically famous route from Italy to Germany across the Alps via the Brenner Pass.

Trento is surrounded by massive peaks of the Dolomite and Alpine chains, some of them exceeding 7,000 ft. in elevation. The climate is generally moderate, but with cool winters. The average rainfall is over 40 in. In addition to its function as a regional market place and administrative center, the city has a number of small industries: textiles, cement, chemicals, flour, and wines.

In pre-Roman times the area around Trento was occupied successively by Ligurians, Illyrians, Etruscans, and Celts. The city, known to the Romans as Tridentum, was conquered by them in 222 B.C. and in time became a great military post. The Lombards made it the seat of their northernmost duchy, but during later Germanic invasions it suffered badly. After the Carolingian epoch it was for a time part of the March of Verona and in 952 was added to the German kingdom as a strongpoint guarding the southern approaches

EWING GALLOWAY

*CASTELLO DEL BUON CONSIGLIO, TRENTO*

to the Brenner. Trento also became the seat of an ecclesiastical principality, but it remained closely allied to the imperial cause in the investiture struggle. After resisting Ghibelline attempts to conquer it, Trento came under Hapsburg rule with the end of the temporal power of the bishops in 1363.

Being on the border line between the Italian and German cultures, Trento was pulled both to the north and south in its interests and loyalties, and partly for this reason Trento was the site of the great Church council which met off and on from 1545 to 1563 to conjure the Protestant danger.

Napoleon took Trento in 1796, and French forces entered it again in 1797, 1801, and 1809. The region was the scene of a revolt by the Tirolese population against French rule. In 1810 it became the capital of the French department of the Alto Adige, but in 1814 it returned to the Hapsburg control. As a fundamentally Italian city, Trento became a center of Irredentist agitation after the creation of United Italy. Although briefly evacuated by the Austrian army in the war of 1866, it was not united with Italy until after World War I. During the period preceding that conflict the Austrians heavily fortified the city, and it was not entered by Italian troops until Nov. 3, 1918. Trento was bombed in World War II because of its position along the vital rail line to the Brenner Pass. Pop. (off. est. 1947), 62,611.

**The Province.** The province of Trento, comprising 127 communes, has an area of 2,516 sq. mi. Except for the narrow valleys of the Adige River and a few of its larger tributaries, the province consists of mountainous terrain, rising in the northeast to over 10,000 ft. in the Dolomites and to a similar height in the Adamello Massif to the west. The principal agricultural products are grapes, wheat, corn, hay, fruit, and cattle.

The hydroelectric industry is highly developed in Trento. Secondary industries include cement, textiles, printing, and furniture. Aluminum and iron are mined, and marble is quarried. The tourist industry is normally one of the leading sources of income. A great deal of rebuilding had to be done during the early years of Italian rule as a result of the vast damage wrought in World War I. Pop. (off. est. 1947), 405,000.

R. G. W.

**TRENTON,** a town in Pictou Co., Nova Scotia, Canada, situated on the bank of the East River of Pictou Harbour, 105 mi. northeast of Halifax. The Canadian National Railways provide transportation. The industrial activities center in the steel rolling mills and railway shops. The town was incorporated in 1911. Pop. 1951, 3,089.

D. F. P.

**TRENTON,** a town and port in Hastings Co., Ontario, Canada, at the mouth of the Trent River on the picturesque Bay of Quinte, an arm of Lake Ontario, 100 mi. northeast of Toronto, on Provincial Highway 2. The Canadian National and Canadian Pacific railways furnish transportation. It is the southern terminus of the Trent Canal System while the Murray Canal, through the narrow isthmus at Carrying Place, gives Trenton direct access to Lake Ontario. Manufactures include canned goods, cottons, paper, and silverware. Pop. 1951, 10,085. D. F. P.

**TRENTON,** a village in Wayne Co., in southeastern Michigan, situated on the Detroit River, about 14 mi. south of Detroit. This industrial community, chartered in 1875, has freight transportation provided by the New York Central, the Detroit and Toledo Shore Line, and the Detroit, Toledo and Ironton railroads. Distilled alcohol and chemicals derived from the limestone quarried in the immediate vicinity are the chief industrial products. There is a large electric power plant in Trenton. Pop. 1950, 6,222.

**TRENTON,** a city in northern Missouri, the county seat of Grundy Co., situated 75 mi. northeast of Kansas City. Coal mines and rock quarries are near by, but the region is chiefly agricultural and devoted to dairy, grain, and poultry farms and stock raising. Trenton was settled in 1834 and was first known as Bluff Grove or Lomax's Store. It was platted in 1841. Trenton, the seat of a junior college, is administered by a mayor and council. Crowder Memorial State Park, named for Maj. Gen. Enoch H. Crowder, deviser of the selective service act of World War I, is 4½ mi. northwest. Trenton is served by the Chicago, Rock Island & Pacific Railway. Local industrial plants include railroad machine shops, bottling works, a cannery, a creamery, and hatcheries. Pop. 1950, 6,157.

**TRENTON,** the capital city of New Jersey, the county seat of Mercer Co., in west central New Jersey, situated at the head of tidewater navigation of the Delaware River, 48 mi. southwest of Newark and 30 mi. northeast of Philadelphia, Pa. The first white settler on the site was Mahlon Stacy, an English Quaker, who took up a grant of land in 1679 and built a log mill and a house, around which a small community formed. In 1714 William Trent, a Philadelphia merchant, bought a large portion of the Stacy property, and he backed the settlement's development. The house which he built in 1719 is the city's oldest standing home. The village became known as Trent's Town, and its position at the head of sloop navigation made it a shipping point for the area's produce and a depot for merchandise between Philadelphia and New York City. Ferry service, chartered in 1727, afforded communication with Pennsylvania, and it was one of the chief stopping places on King's Highway in Colonial times. During the French and Indian War royal troops were quartered in the town. Occupied alternately by Colonial and Hessian forces, Trenton was the scene of one of the most important and decisive battles of the Revolutionary War. In 1784 Congress convened in Trenton and decided to make it the country's capital, but this motion was defeated in the following year. Selected as the state capital in 1790, Trenton was incorporated as a city in 1792. In 1794 the Federal Government was located temporarily in the city. Communication with Pennsylvania, particularly Philadelphia, was facilitated with the completion of a bridge across the Delaware in 1804. The city has the commission form of local government.

There are many historical landmarks in the city, including the Old Barracks, quarters of troops in the French and Indian War and of Hessian troops in the Revolutionary War; Douglass House, where Washington planned the second battle of Trenton; Old Masonic Temple, built in 1793; the Battle Monument, marking the spot where the Continentals first fired on the Hessians; the Old Friends Meeting House, built in 1739, in whose grounds is buried George Clymer, a signer of the Declaration of Independence and the Constitution; and the park a few miles northwest of the city commemorating Washington's crossing of the Delaware. Other sites of interest include the Soldiers' and Sailors' War Memorial, the City Hall, the Statehouse, the state museum, and Trenton Municipal Colony, a municipal welfare institution. Trenton is the seat of a state teachers' college, Rider College, a state asylum, a state penitentiary, a state school for girls, and a state school for the deaf. It was the home of John and Washington Roebling, famous bridge engineers.

Transportation facilities are furnished by the Pennsylvania and Reading railroads and by coastwise and ocean-going steamers. In Colonial days local residents made potteries from the clay in the region, but it was not until after 1850 when craftsmen were brought over from England and Ireland that the industry developed extensively. Trenton is widely known as a production center for some of the nation's finest chinaware, as well as various other potteries and ceramics. Trenton's industrial output includes wire and cable, soft and hard rubber goods, steam turbines, automobile accessories, cigars, structural steel, asbestos, clothing, dies, metal products, canned goods, textiles, and aviation supplies. The cable equipment used in the construction of the Brooklyn, Golden Gate, and San Francisco Bay bridges was produced in Trenton. Pop. 1950, 128,009. S. D. M.

**TRENTON, BATTLE OF,** Dec. 26, 1776, an important American victory in the Revolutionary War. Following the loss of New York City in September 1776 and the subsequent battle of White Plains, General George Washington retreated across New Jersey. Harried by the pursuing British and losing almost three fourths of his army because of illness or desertions, he managed to transport his Continental troops across the Delaware River into Pennsylvania in December. His commandeering of all boats for some distance up and down the river stalled the British on the east bank, and the enemy went into winter quarters. Facing the loss of many of his remaining troops, whose enlistments were to expire at the end of the year, and knowing that Philadelphia was in danger, Washington planned a bold move. Scouting reports told him that Hessian troops billeted in Trenton were scattered and practically without defenses. Despite a bitter storm, Washington crossed the Delaware on Christmas night. One segment of his command, ordered to strike the Hessian troops at Bordentown, south of Trenton, was too late to be effective, and another group, to the north, failed to make the crossing. The third force, under Washington, succeeded in reaching the Jersey shore north of the city. The Americans quickly penetrated the picket lines and advanced through the city, taking the Hessians almost completely by surprise in the early hours of December 26. The mercenaries resisted briefly but, with their retreat cut off, soon surrendered. The Americans returned to Pennsylvania with almost 1,000 prisoners and great quantities of arms and stores. The victory gave new life to the American cause, and led to the successful battle of Princeton and the eventual withdrawal of the British from New Jersey. M. Je.

**TREPAK** [trɛpɑ′k], a Russian dance in brisk duple meter performed by Cossacks. A famous example is to be found in Tchaikovsky's *Nutcracker Suite.* P. N.

**TRESPASS,** in law, a term which, in its more comprehensive sense, is defined as any misfeasance or act whereby another is injuriously treated or damaged. The term has also been defined as an unlawful act committed with violence, actual or implied, to the person, property, or rights of another, or any unauthorized entry upon the real estate of another. However, in the nomenclature of the common law, an act of injury has been generally deemed a trespass only if the damage was directly and immediately occasioned by such act; if, on the other hand, the act of injury merely created a condition later responsible for harm to another, it has been referred to, in distinction, as a "trespass on the case." Actionable negligence is generally deemed a trespass only if the act complained of is affirmative in nature, and not merely a negligent omission to perform a duty.

In its modern, restricted, and ordinary sense, on the other hand, trespass is simply an entry on land without lawful authority, giving rise to an action for damages, in which, if the act of trespass has been committed maliciously, or under other aggravating circumstances, exemplary damages may be recoverable.

The various forms of common-law trespass to the person or to personal property are now generally grouped separately for the purpose of identification and treatment, under such legal headings, for example, as "Assault and Battery," "False Imprisonment," "Negligence," and "Conversion." H. Si.

**TREVELYAN, GEORGE MACAULAY** [trɪvɛ′lyən] (1876- ), English historian, was born on Feb. 16, 1876, and educated at Harrow and Trinity College, Cambridge. From 1915 to 1918 he commanded the first British ambulance unit sent to Italy in World War I. In 1927 he was appointed Regius Professor of Modern History at Cambridge, a position from which he resigned when he became Master of Trinity College, Cambridge, in 1940. He received the Order of Merit in 1930 and became a Fellow of the British Academy. His historical works are written with literary brilliance and sound scholarship; the most important are *England in the Age of Wycliffe* (1899), *England under the Stuarts* (1907), *Garibaldi's Defense of the Roman Republic* (1907), *Garibaldi and the Thousand* (1909), *Garibaldi and the Making of Italy* (1911), *Life of John Bright* (1917), *Lord Grey of the Reform Bill* (1920), *British History in the Nineteenth Century, 1782-1901* (1922), *Manin and the Venetian Revolution of 1848* (1923), *England under Queen Anne* (3 vols., 1930-1934), and *English Social History* (1944). He also wrote *An Autobiography* (1949). E. R. A.

**TREVELYAN, SIR GEORGE OTTO** (1838-1928), English historian, was born in Rothley Temple, Leicestershire, July 20, 1838. Educated at Harrow and Trinity College, Cambridge, he went to India in 1862 as secretary to his father, Sir Charles Trevelyan, then financial member of the Council of Calcutta. In 1865 he was elected to the House of Commons, where he sat as a member from 1868 to 1897. From 1868 to 1870 he was a Civil Lord of the Admiralty, from 1880 to 1882 Secretary to the Admiralty, and from 1882 to 1884 Chief Secretary for Ireland. He was Secretary for Scotland in 1886 and again in 1892. In 1911 he was awarded the Order of Merit. His first work of importance was *The Life and Letters of Lord Macaulay* (1876), an excellent biography of his uncle; other works that merit attention are *The Early History of Charles James Fox* (1880), *The American Revolution* (4 vols., 1909), and *George III and Charles Fox* (2 vols., 1912-1914). Trevelyan wrote history from the Whig point of view, however, and his work on the American Revolution has been the object of considerable criticism. He died Aug. 17, 1928, at Wallington, Northumberland. E. R.A.

**TRÈVES.** *See* TRIER.

**TREVISO** [trevi′zo], a province and also the capital city of the province, in an agricultural region, in the central part of the region of Veneto, in northeastern Italy.

**The City.** Treviso is situated astride the Sile River in the Venetian Plain about halfway between the mountains and the sea, at 45° 40′ N. lat. and 12° 15′ E. long., at an elevation of 50 ft. above the level of the Adriatic. The climate is characterized by hot summers and temperate winters, with the rainy season coming in the spring and summer. Treviso is a market place for the fertile farming region in which it lies and also possesses several industrial establishments, including flour mills, potteries, cement and fertilizer plants, paper factories, and machine shops. It is an important railway center, with lines running to Venice, Udine, Belluno, Vicenza, and Milan. The older part of town is enclosed within three miles of walls built early in the sixteenth century and in part protected by moats; some of the latter have been filled in to form parks. This part of the city is traversed by several canals and in general has a medieval atmosphere, with narrow, crooked streets and old buildings. The newer quarters, outside the walls, are modern and spacious. The principal monuments include the Palazzo Provinziale, the Palazzo dei Trecento (1207, Romanesque), a cathedral and its baptistery, and the churches of Sant' Agostino (eighteenth century) and San Niccolò (thirteenth century Gothic). Treviso, Roman Tarvisium, became the seat of a duchy under the Lombards. Later the bishop acquired power but in turn was finally deprived of political functions in the early thirteenth century by the expanding commune. The latter, however, fell prey to a succession of *signori,* concluding with the La Scala family who ceded Treviso to Venice in 1339. With brief interludes, Venetian rule lasted until the end of the republic in 1797. During the late Middle Ages and early modern period the city was a minor center of art and learning. After the Napoleonic Era it passed to Austria and remained under Hapsburg dominion until 1866. During World War I Treviso became the headquarters of the Italian army after the disaster at Caporetto in the fall of 1917. It suffered considerably from enemy action. Pop. (off. est. 1947), 63,067 (including suburbs).

**The Province.** The province of Treviso, comprising 90 communes, has an area of 956 sq. mi. Seven tenths of the territory is on the Venetian Plain and the remainder in the foothills of the Dolomites. The province does not quite reach to the Adriatic. It is drained chiefly by the Piave, Livenza, Sile, and Zero rivers. Agriculture and animal husbandry are the leading activities. Practically all of the arable land is cultivated, and much of it is irrigated by an extensive system of canals and ditches. The principal products are wheat, corn, hay, grapes, fruit, flax, sugar beets, vegetables, and tobacco. Cattle and swine are raised in large numbers, while the province is noted in Italy for the production of silk cocoons. Besides Treviso, other important centers are Vittorio Veneto, site of the Italian victory over the Austrian army at the end of World War I (Oct. 24 to Nov. 3, 1918); and Conegliano. Pop. (off. est. 1947), 618,000. R. G. W.

**TRIAD** [trai'æd], in music, a chord of three notes built up by intervals of thirds, as C-E-G. The note C is known as the root or fundamental of this triad. Hence when C is in the bass, the triad is said to be in root (fundamental) position; when E, in first inversion; when G, in second inversion. Triads are classified according to their intervals as major, minor, diminished, and augmented. A major triad contains a major third and a perfect fifth, as C-E-G; a minor triad, a minor third and a perfect fifth, as C-E♭-G; a diminished triad, a minor third and a diminished fifth, as C-E♭-G♭; an augmented triad, a major third and an augmented fifth, as C-E-G♯. J. M. Ba.

**TRIAL.** *See* Legal Procedure.

**TRIANGLE.** *See* Geometry; Trigonometry.

**TRIANGLE,** an instrument used in Occidental music since the fifteenth century. Originally it had a trapezoidal shape, but from the seventeenth century onward it has consisted of a thin steel rod bent into triangular form, suspended by a cord and struck with a small metal beater. After several centuries of diversified use, it was introduced into the eighteenth-century orchestra as a coloristic effect, chiefly in imitation of the stick-rattle characteristic of Turkish military music. During the nineteenth century the triangle lost its coloristic connotations and became an ordinary member of the orchestra's percussion section. W. Li.

**TRIANGULUM** [traiæ'ŋgyuləm], the Triangle, an ancient northern constellation, between Andromeda and Aries. Its only noticeable asterism is a small right triangle of three stars of third and fourth magnitude. Its other stars, which are dimmer, include many interesting double stars. The large spiral galaxy M 33, near the western boundary, is one of the nearer extragalactic nebulae, so called because it is beyond the Milky Way. It is around 720,000 light-years distant from the earth. J. H. P.

**TRIANGULUM AUSTRALE** [ɔstre'li], the Southern Triangle, a small constellation centered at approximately right ascension, 16 hr.; declination, —65°. The triangular figure is conspicuous, since three stars of the second and third magnitudes mark the angles. The remaining stars are faint. The constellation cannot be seen north of the latitude of New Orleans. J. H. P.

**TRIASSIC PERIOD.** *See* Geology.

**TRIBES OF ISRAEL, TWELVE.** In Biblical tradition the ancient Hebrews, descended from Jacob (or Israel), were divided into twelve tribes, bearing the names of Jacob's sons, except in the case of the tribes of Manasseh and Ephraim: these represented the descendants of Jacob's son Joseph and bore the names of Joseph's two sons. The descendants of Jacob's son Levi are not included in the count of twelve, for the tribe of Levi, devoted to the service of the Lord, had no territory in Canaan and lived scattered throughout the land. A common arrangement in lists of the tribes is according to their maternal descent, as follows: Leah tribes: Reuben, Simeon, Levi, Judah, Issachar, Zebulun; Zilpah tribes: Gad, Asher; Rachel tribes: Ephraim and Manasseh, Benjamin; Bilhah tribes: Dan, Naphtali.

The tribe was composed of a group of families, united by a blood tie and constituting a social and political unit. As time went on, the stronger tribes tended to absorb the weaker ones. After the establishment of the monarchy the tribes ceased to function independently and largely lost their individual identity, but the concept of twelve tribes of Israel persisted and occurs in relatively late Hebrew literature.

The modern critical view of the Israelite tribes differs considerably from the traditional. In the critical view the ancient Hebrew nation was formed by a confederation of originally nomadic tribes who entered Canaan at different times, though probably in groups of several tribes at a time; it is considered highly improbable that these tribes were descended from one man (Jacob). M. A. G.

**TRIBUNE,** a Roman official. The tribuneship at Rome originated in the struggle between the patricians and plebeians during the early republican period. The board of ten tribunes was annually elected by the plebeians to provide a group of officials which would be devoted to the interests of the people. The tribune had the power to veto any act of a Roman magistrate or to halt the proceedings of the senate. The tribune himself was sacrosanct; to disobey him was an offense punishable by death. Although they were unable to exercise military command or any considerable judicial power, the tribunes could call meetings of the *comitia tributa* and the senate and suggest legislative action to be taken by those bodies. T. B. J.

**TRICHINA** [trɪkai'nə], *Trichinella spiralis,* a true nematode round worm of the phylum Nemathelminthes. It is the cause of human trichinosis, a disease widely distributed in various parts of the world. It is estimated that there are about 20,000,000 persons affected in the United States. The infection is established by eating raw or improperly cooked pork containing the cysts of the larvae. The cysts are digested in the stomach, releasing the larvae, which migrate to the intestine where they become sexually mature. The females are viviparous, and a single worm may deposit as many as 1,800 progeny in about six weeks. The young parasites find their way into the lymphatics and venules and are distributed to various parts of the body, eventually encapsulating (encysting) in the muscles, especially the diaphragm, tongue, and chest muscles. The spiral form taken by the worms in muscle is responsible for the specific name *spiralis.* After a period of several months the host deposits calcium around the encysted worms. This process is called calcification. It is estimated that, in a man, five worms for every gram of body weight can produce death. The pathological lesions result from mechanical and toxic irritations produced by the worms during the invasion, migration, and encystations. Worms often invade the heart muscles causing myocarditis. Those in the diaphragm interfere with the proper function of this important respiratory organ. No effective treatment is known. The best preventive measures are the proper inspection of pork and its thorough cooking. R. F. N.

**TRICHINOPOLY** or (officially) **TIRUCHIRAPALLI** [trɪ'tshɪnɒ'pəli; tɪru'tshɪrʌpʌ'], an important city in southeastern India. It is located in Madras State at the head of the delta of the Cauvery River. The fertile alluvial soil and the warm to hot climate make the region an excellent one for agriculture. The rainfall averages 40 in. a year, most of it falling during October, November, and December; during the rest of the year Trichinopoly is hot and dry, and, because of this, agriculture is largely dependent upon the irrigation provided by the Mettur Dam and Irrigation Project. Rice, millet, cotton, grain sorghum, peanuts, sugar cane, and tobacco are grown in the densely settled Trichinopoly district, and the city of Trichinopoly serves as the market and

administrative center. The city is an important railway junction and educational and industrial center, well known for cigar manufacturing and silk weaving. A 273-ft. rock in the center of the city has a Siva temple at its base and a Ganesa temple at its summit, which affords a panoramic view of the surrounding region. Pop. 1951, 218,921.

J. E. F.

**TRICHOMONIASIS.** *See* PROTOZOA (*Diseases*).

**TRICHOPTERA** [trɪkɒ′ptərə], the scientific name of the order of insects commonly known as caddice flies or caddis worms. In the larval stage, they are aquatic, and most of them build cases in which they travel about. The larvae of some species construct web nets in which they catch their food. Many of the adults resemble moths but they can be distinguished by the presence of hairs rather than scales on the wings. *See also* CADDICE FLY.

C.H. Cu.

**TRIER** [tri′r] (*Fr.* Trèves), a commercial and historic town in the state (*Land*) of Rhineland-Palatinate, in the (West) German Federal Republic, 6 mi. east of the Luxembourg frontier and about 55 mi. southwest of Koblenz. The town lies on the Moselle River, in a valley amid vine-clad hillsides with the Hunsrück Mountains in the background. Reputed to be Germany's oldest city, Trier was capital of the Treviri, a tribe of Belgic Gauls that was conquered in 56 B.C. by Julius Caesar. It then became the Roman colony Augusta Trevirorum, later the capital of the province of Gallia Belgica. Trier was made a bishopric in 328 and became an archbishopric in the ninth century. Medieval Trier was an important crossroads trading center and a seat of monastic scholarship. Clemens Wenceslaus, the last elector and a Saxon prince, transferred his residence to Koblenz in 1786. Karl Marx was born in Trier in 1818. From 1918 to 1923 United States troops occupied the town. In World War II the town not only was heavily bombed but also received intensive artillery shelling, resulting in severe damage and destruction. After the war Trier was included in the French zone of occupation. Prior to 1942 there were many fine old buildings and Roman remains, but few escaped damage. The old cathedral, which was begun before the fourth century as a Roman basilica and was extended during the next thousand years, was ruined. The Church of Our Lady, connected with the cathedral by cloisters, is said to have been the first Gothic church in Germany; it was largely ruined. The quaint Market Place, with the fifteenth-century Rotes Haus, was devastated. The Abbey of St. Matthew was severely damaged. Among the noteworthy Roman remains are included the fourth-century Basilica; the third-century amphitheatre; the Porta Nigra, a fortified gate predating the fourth century and the finest Roman structure remaining in Germany; and the Roman Baths. Trier is the head of barge navigation on the Moselle, which, however, is not greatly utilized because of its numerous turns and windings. The town is famous for its trade in Moselle and Saar wines and is a rail junction. Prewar industries included leather-goods factories, breweries, rolling mills, and champagne cellars. Pop. 1953, 83,700.

C. C. H.

**TRIESTE** [triɛ′ste; triɛ′st], a city and province of the region of Friuli-Venezia Giulia, in northeast Italy. The province is located on the eastern and southern shores of the Gulf of Trieste, at the head of the Adriatic Sea, and is bounded on the north by the province of Gorizia and on the east and south by the Republic of Slovenia in Yugoslavia. Between February 1947 and October 1954, the province, including the city of Trieste, constituted the northern portion of the Free Territory of Trieste, established by a peace treaty between Italy and the Allies at the end of World War II. This Free Territory, with an area of about 285 sq. mi., was located on the northwest side of the Istrian Peninsula. Of its population of about 350,000, almost 300,000 were Italian, and the great majority of these lived in the commune of Trieste; most of the rural inhabitants were Slovenes.

**The City.** The port city of Trieste lies on the northernmost extension of a belt of sandstone hills that slopes steeply from the Carso Plateau (elevation about 1,300 ft.) down to the sea. In general, the city has a modern appearance, with most of the old city at the base of the hill of San Giusto.

Small valleys, some of them suitable for farming, are interspersed among the rocky hills, but 95 per cent of the food consumed in this zone must be imported. The climate is generally moderate, though July and August may be uncomfortably hot. The temperature seldom goes below freezing, but a severe northeast wind, the *bora,* blows in winter and sometimes attains a velocity of over 100 mph.

Trieste is a natural port for landlocked Austria, Czechoslovakia, and Hungary, as well as for the adjacent areas of Italy and Yugoslavia. Damage resulting from World War II was extensive, however, and the shipping industry was particularly affected. Furthermore, the decline in intra-European trade and the Cold War meant a great reduction in the city's commercial activity. During the period of the Free Territory, Trieste, with its principal economic and political ties either cut or restricted, was unable to balance its economy through commercial and industrial enterprises, essential to a city lacking resources.

Shipbuilding is a principal industry in Trieste; other establishments include oil refineries, canneries, iron and steel works, silk plants, and paper works. In the region southwest of the city bauxite is mined, and marble and limestone are also quarried. Family artisans produce various commodities in substantial quantities. In the province most of the cultivated area is occupied by orchards and vineyards, and fishing is important.

The principal exports are ships, petroleum products, vegetable oils and their by-products, and semifinished iron and steel products; most exports go to Italy. The main imports are foodstuffs, coal, crude oil, and industrial raw materials. The province has over 550 mi. of highway and over 60 mi. of railroad, and Trieste is on the Simplon-Orient Express route.

Since its liberation in 1945, Trieste received continual relief, primarily from the United States, though Italy and the United Kingdom also made substantial contributions. Economically, Trieste is unable to survive without aid under present world conditions.

**History.** Founded by the Carnic Gauls, Trieste became the Roman colony of Tergeste in the first century before Christ. Later, the city was held by the Byzantine Empire, except for brief periods of Gothic and Lombard rule, until Charlemagne took it in 787. In 948, King Lothair II granted it independence, and Trieste remained free until its capture by Venice in 1202; in 1382, it was taken by the Hapsburgs. Trieste's basis as one of the great ports of the world was laid by Charles VI, who proclaimed Trieste a free port in 1719 and proceeded to make it the principal sea outlet for his empire. Both the city and its trade suffered during the Napoleonic Era, but after the return of the city to Austria in 1813, the economic importance of Trieste grew with the increase of trade in central Europe. Meantime, Aus-

trian political repression in Trieste had the effect of encouraging liberal and Italian national movements, and in the 1860's Austria began to encourage the entry of Slavic and other non-Italian elements into the area in an effort to offset the predominantly Italian native population. Nevertheless, Trieste remained Italian in allegiance, and at the end of World War I it was occupied by Italian troops; it was awarded to Italy in 1920. Toward the end of World War II, Trieste was occupied by German troops, but in 1945 it was liberated by the forces of Marshal Tito and by those of the United Kingdom and the United States.

At the close of World War II, Yugoslavia wished to annex Trieste, but since Yugoslavia had strong ties with the Soviet Union at this time, the British and American governments sought to uphold a balance of power by supporting the Italian claims. Allied representatives suggested frontiers corresponding to the boundary between Italian and Slavic populations, but there appeared to be no geographical separation of the ethnic elements, and any attempted solution seemed bound to arouse some dissatisfaction in the Territory. The Free Territory of Trieste was constituted by the Italian Peace Treaty as a compromise between the conflicting interests of the Western powers and Soviet Russia, and without regard to the disposition and wishes of the population. Under the terms of the treaty, Trieste was to be a free port, and the city and surrounding area were to become a free, independent territory under a Governor General to be appointed by the United Nations Security Council as its representative. Pending the appointment of a governor, on which the Security Council could not agree, the territory was occupied by the British and United States forces (zone A), and Yugoslavian forces (zone B). During the next year, the British and United States governments asserted that Yugoslavia was virtually incorporating its zone of occupation into the mother country, while the Yugoslavian government claimed that the United Kingdom-United States authorities were planning the ultimate union of the zone with Italy. On Mar. 20, 1948, the governments of the United States, the United Kingdom, and France declared Trieste's right to be returned to Italy. The Soviet Union opposed the return and nothing was done to implement it. The subsequent break between Marshal Tito of Yugoslavia and Stalin dampened the Allied enthusiasm for the return of Trieste to Italy.

The British and American governments, eager to be relieved of their responsibility, made a number of steps toward the eventual integration of the zone into Italy and, on May 9, 1952, they provided for the appointment of an Italian political adviser to the commander of the zone, and the civil administration, except in police matters, was Italian. This move was protested by the Soviet Union and, independently, by Yugoslavia, which then proceeded to make its zone virtually part of Yugoslavia.

On May 25, 1952, elections were held in the United Kingdom-United States zone of Trieste. An Italian coalition group favoring the government of De Gasperi was elected.

On Oct. 8, 1953, the United States and Great Britain announced their decision to withdraw their troops from Zone A and turn over that administration to the Italian government. Yugoslavia protested and the decision was withdrawn pending a settlement acceptable to Yugoslavia.

By May 1954, after negotiating separately with Italian and Yugoslav representatives, British and American diplomats reached a tentative agreement with the Yugoslavs on the main points of a settlement plan to be submitted to Italy. The agreement was formally initialed by the Italian and Yugoslav ambassadors in London on October 5. It provided for a *de facto* partition of the Free Territory, with Trieste and most of Zone A coming under Italian administration, while Yugoslavia received Zone B and a small strip of Zone A extending over an area of about 9 sq. mi. and inhabited by over 3,000 people, mostly Slovene. Italy got an area of 86 sq. mi. with a population of about 300,000, predominantly Italian and mostly living in the city of Trieste (pop. c. 280,000); Yugoslavia received an area of over 200 sq. mi. with a population of about 75,000, almost two thirds of them Italian. Trieste was to be maintained as a free port. S. J. H.

**TRIFOLIUM.** *See* Clover.

**TRIFORIUM.** *See* Architectural Terms.

**TRIGGERFISH,** *Balistes carolinensis,* a small, compressed fish of a tropical family, the Balistidae. It is distributed from the Dutch West Indies northward to Nova Scotia but is most common in the South. The triggerfish is named for the peculiar-looking arrangement found in the three spines of the first dorsal fin that are set in a trough. Once erected, the first and second spines cannot be forcibly depressed by external pressure. However, if the third spine or trigger is depressed the others fold automatically. The triggerfish reaches a length of about twelve inches. Several other species, including the brilliantly colored queen triggerfish, *B. vetula,* occur along the south Atlantic coast. The famous humuhumu-nukunuku-apaa of Hawaii, which is sometimes poisonous, owing to the occasional presence of an alkaloid, belongs to this group. E. C. R.

**TRIGLYPH.** *See* Architectural Terms.

**TRIGONOMETRY** [trĭ'gŏnd'mĭtri] (*trigonon,* triangle +*metron,* a measure), that branch of mathematics concerned with the measurement of lengths and angles. This aspect of the subject differs from geometry mainly in its use of the methods of algebra, and in the fact that its principal goal is to yield numerical answers. A given angle is usually expressed in terms of the ratios of the sides of a right triangle which contains the angle. Trigonometry also investigates the relationship and behavior of these ratios. This phase of the science bears little resemblance to geometry, forming part of the theory of functions.

**Historical.** The first significant contributions to the subject were made by the Greeks, mainly in conjunction with their astronomical investigations. Hipparchus of Nicaea (c. 140 B.C.), a mathematician and astronomer, was the first to make systematic use of trigonometry, and is regarded as its founder. He wrote a treatise on the calculations of chords of angles, and there is evidence that he made use of relationships similar to some of those in modern trigonometry. Menelaus of Alexandria (c. 100 B.C.) made many contributions to spherical trigonometry, which was being developed faster than plane trigonometry because of its important role in astronomy. The work of these men was continued by Ptolemy of Alexandria (c. A.D. 125), whose great work, the *Almagest,* exerted a profound influence on astronomy and trigonometry for a thousand years.

After Ptolemy, the science passed to mathematicians of the East, principally the Hindus and Arabs. They constructed tables of half-chords which are equivalent to sines, introduced the idea of tangent and cotangent, discovered many new theorems, and after ten centuries transmitted their knowledge back to Europe.

The subject was revived in the West during the fifteenth

century, chiefly through the efforts of Georg von Purbach (1423-1461) and his pupil Johann Müller (Regiomontanus) (1436-1476). The latter translated the Almagest, made many original contributions, and for the first time treated trigonometry as a subject independent of astronomy.

The methods of analysis were applied to trigonometry largely by John Bernoulli (1667-1748), Abraham de Moivre (1667-1754), and Leonhard Euler (1707-1783).

## PLANE TRIGONOMETRY

**The Angle.** If two straight lines are drawn at right angles to each other, they divide the plane into four regions, called quadrants. These are usually numbered in a counterclockwise direction, as in Fig. 1. An angle may be thought of as swept out, or generated, when line $OX$ revolves about point $O$. The counterclockwise direction is generally taken as positive. A complete revolution of $OX$ is equivalent to an angle of 360 degrees. Each degree is divided into 60 minutes, and each minute further subdivided into 60 seconds. Another useful unit of angle is the radian. It is the angle subtended by a circular arc equal in length to the radius. $2\pi$ radians $= 360°$, or 1 radian is equal very nearly to $57°\ 17'\ 45''$.

**The Right Triangle.** Etymologically the word trigonometry means the science of the measurement of triangles. Today this description is no longer all-inclusive. However, the right triangle is of particular importance, since, first, certain ratios basic to the subject are defined in terms of the sides of right triangles, and, secondly, complicated plane figures may be dissected into right triangles and analyzed in terms of these ratios.

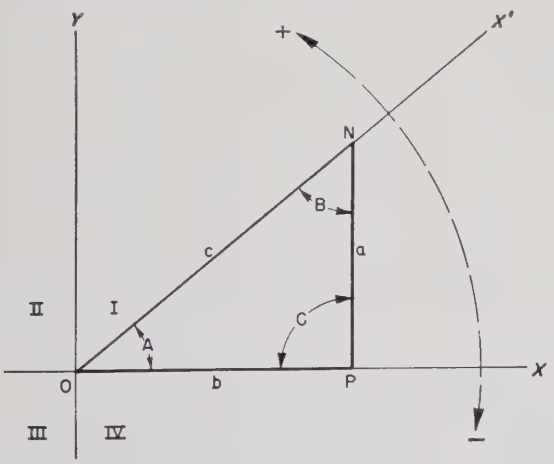



*Fig. 1—TRIGONOMETRIC RATIOS AND FUNCTIONS IN A RIGHT TRIANGLE*

Consider the right triangle $ONP$ of Fig. 1. Six possible ratios may be formed from the lengths of its sides. These are: $a/c$, $b/c$, $a/b$, $b/a$, $c/b$, $c/a$.

Since all right triangles having an equal acute angle are similar, the values of these ratios depend only upon the size of angle $A$. They are, in other words, trigonometric functions of angle $A$. They are named, abbreviated, and identified in the following way:

$a/c$ = sine of angle $A$ = sin $A$ = opposite side/hypotenuse
$b/c$ = cosine of angle $A$ = cos $A$ = adjacent side/hypotenuse
$a/b$ = tangent of angle $A$ = tan $A$ = opposite side/adjacent side
$b/a$ = cotangent of angle $A$ = cot $A$ = adjacent side/opposite side
$c/b$ = secant of angle $A$ = sec $A$ = hypotenuse/adjacent side
$c/a$ = cosecant of angle $A$ = csc $A$ = hypotenuse/opposite side

Certain less common functions of angle $A$ are:

versed sine of $A$ = vers $A$ = 1 − cos $A$
coversine of $A$ = covers $A$ = 1 − sin $A$
exsecant of $A$ = exsec $A$ = sec $A$ − 1
haversine of $A$ = hav $A$ = ½ vers $A$

Tables of the values of various functions have been constructed for a large number of angles. This has been done by using the methods of the calculus to express these functions as infinite series of algebraic terms. The values of the functions of several commonly encountered angles are given to three decimal places in the following table:

| | 0° | 30° | 45° | 60° | 90° |
|---|---|---|---|---|---|
| *sin* | 0.000 | 0.500 | 0.707 | 0.866 | 1.000 |
| *cos* | 1.000 | 0.866 | 0.707 | 0.500 | 0.000 |
| *tan* | 0.000 | 0.577 | 1.000 | 1.732 | ∞ |
| *cot* | ∞ | 1.732 | 1.000 | 0.577 | 0.000 |
| *sec* | 1.000 | 1.155 | 1.414 | 2.000 | ∞ |
| *csc* | ∞ | 2.000 | 1.414 | 1.155 | 1.000 |

Division by zero is undefined in mathematics, and the infinity symbol, ∞, in this table simply implies that the function becomes larger than any pre-assigned number as the angle indicated is approached.

**Fundamental Identities.** A group of elementary but important relationships between the trigonometric functions follows directly from their definitions. These are known as the fundamental identities. Thus, it is evident that the following reciprocal relations hold: sin $A$ csc $A = 1$, cos $A$ sec $A = 1$, and tan $A$ cot $A = 1$. Also, since $a/b$ may be written $\dfrac{a/c}{b/c}$, it follows that tan $A = \sin A/\cos A$. A third group of relationships may be obtained by applying the Pythagorean theorem to triangle $ONP$ of Fig. 1. This theorem states $a^2 + b^2 = c^2$. Dividing this equation by $c^2$, $(a/c)^2 + (b/c)^2 = 1$; or, $\sin^2 A + \cos^2 A = 1$. Division by $b^2$ yields $1 + \tan^2 A = \sec^2 A$; and by $a^2$, $1 + \cot^2 A = \csc^2 A$.

It is also of interest to know the relationship between the function of a given angle, and one that differs from this angle by an integral number of right angles. From Fig. 1, it is observed that $\sin B = b/c = \cos A = \cos(90 - B)$. In fact, it may be stated generally that any function of an acute angle is equal to the corresponding cofunction of the complement of the angle. Some of the relationships of this type are listed as follows:

$$\sin (90 - A) = \cos A$$
$$\cos (90 - A) = \sin A$$
$$\tan (90 - A) = \textit{cot}\ A$$
$$\sin (90 + A) = \cos A$$
$$\cos (90 + A) = -\sin A$$
$$\tan (90 + A) = -\cot A$$
$$\sin (180 - A) = \sin A$$
$$\cos (180 - A) = -\cos A$$
$$\sin (180 + A) = -\sin A$$
$$\cos (180 + A) = -\cos A$$

**Graphs.** An informative way of indicating the behavior of trigonometric functions is by constructing their graphs, as in Fig. 2. It is seen from these curves that the functions are periodic. That is, they repeat their values every 360°. It is also seen that the values of the sine and cosine vary between the limits of 1 and −1, while the tangent may assume all positive or all negative values.

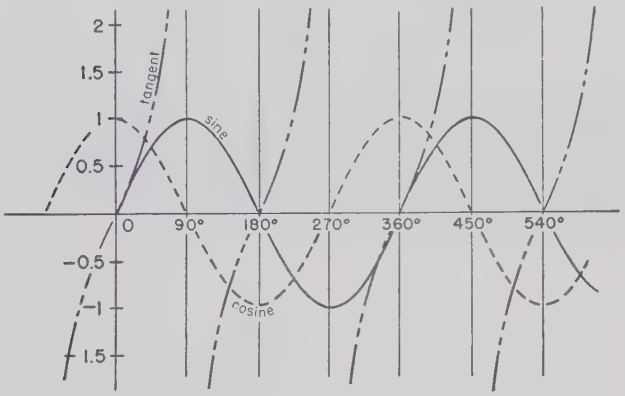



*Fig. 2—GRAPHS OF TRIGONOMETRIC FUNCTIONS*

**The General Triangle.** A triangle is defined if three parts, at least one of which must be a side, are given. (If two sides and an unincluded angle are given, two triangles may be possible.) If the triangle is dissected into right triangles, as in Fig. 3, by dropping perpendiculars from each vertex to the opposite side, it is possible to derive relationships between the known and unknown parts. In the figure, $\sin A = h/c$, $\sin B = k/c$, and $\sin C = h/a = k/b$. Eliminating $h$ and $k$, $\sin A/a = \sin B/b = \sin C/c$, an equation known as the law of sines.

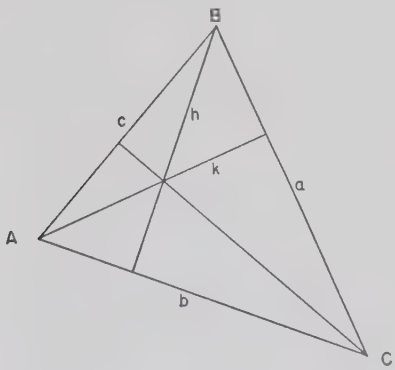



*Fig. 3—VARIOUS TRIGONOMETRIC RELATIONSHIPS IN A GENERAL TRIANGLE*

When two sides and an included angle, or three sides of a triangle, are known, the law of sines will not yield directly the unknown parts. In these cases, a relationship known as the law of cosines is applicable. This may be written: $a^2 = b^2 + c^2 - 2bc \cos A$. When angle $A$ is 90°, $\cos A = 0$, and the equation reduces to the Pythagorean theorem, which is thus a special case of the law of cosines.

**Functions of Two Angles.** It is frequently desirable to express the function of the sum or difference of two angles in terms of functions of the individual angles. Several of these relationships are as follows:

$$\sin (A \pm B) = \sin A \cos B \pm \cos A \sin B$$
$$\cos (A \pm B) = \cos A \cos B \mp \sin A \sin B$$
$$\tan (A \pm B) = \frac{\tan A \pm \tan B}{1 \mp \tan A \tan B}$$

If $A$ is made equal to $B$ in these equations, expressions are obtained for functions of twice an angle, or:

$$\sin 2A = 2 \sin A \cos A$$
$$\cos 2A = \cos^2 A - \sin^2 A$$
$$\tan 2A = 2 \tan A / 1 - \tan^2 A$$

From these equations expressions for functions of half an angle may be derived. Some of these are:

$$\sin A/2 = \pm \sqrt{\frac{1 - \cos A}{2}}$$

$$\cos A/2 = \pm \sqrt{\frac{1 + \cos A}{2}}$$

$$\tan A/2 = \pm \sqrt{\frac{1 - \cos A}{1 + \cos A}}$$

A final group of relations which may be derived from the foregoing permit the sum or difference of functions to be expressed as a product. Thus:

$$\sin A + \sin B = 2 \sin \tfrac{1}{2}(A + B) \cos \tfrac{1}{2}(A - B)$$
$$\sin A - \sin B = 2 \cos \tfrac{1}{2}(A + B) \sin \tfrac{1}{2}(A - B)$$
$$\cos A + \cos B = 2 \cos \tfrac{1}{2}(A + B) \cos \tfrac{1}{2}(A - B)$$
$$\cos A - \cos B = -2 \sin \tfrac{1}{2}(A + B) \sin \tfrac{1}{2}(A - B)$$

**Applications.** Trigonometry plays an important role in navigation, surveying, in almost every branch of engineering, and in many fields of pure science. The following illustration demonstrates the method of solution of a practical problem. A tree is sighted through a telescope which points 10° east of north. The telescope is carried to a second position 75 ft. directly west of the first, from which point the tree is observed 30° east of north. How far is the tree from the first position? In the diagram of Fig. 4, $A$ and $B$ represent the two stations, and $C$ the tree. The two base angles of the triangle are readily seen to be 60° and 100°. Since the angles of any triangle total 180°, angle $C$ must be 20°. Applying the law of sines: $b/\sin 60° = 75/\sin 20$, and $b = 75 \times \frac{0.866}{0.342} = 190$ ft. The values of the sines are obtained from a table of functions.

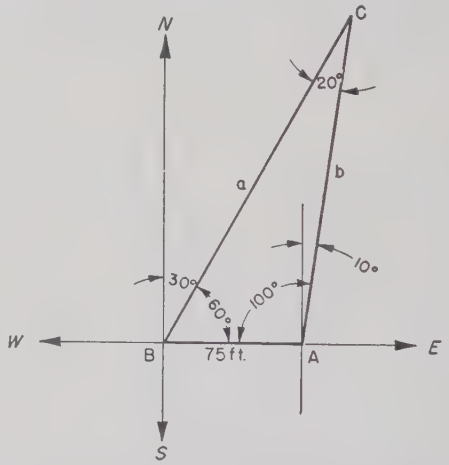



*Fig. 4—PRACTICAL APPLICATION OF TRIGONOMETRY: DISTANCE BETWEEN TWO POINTS*

## SPHERICAL TRIGONOMETRY

A spherical triangle is that part of the surface of a sphere bounded by three arcs of great circles. The principal prob-

lem of spherical trigonometry is that of determining the remaining three parts of a spherical triangle when three parts are known. Solutions of triangles are effected by the use of the same functions as in plane trigonometry. A group of ten basic equations relating the sides and angles of a right spherical triangle can be obtained quite simply. For example, $\sin b = \sin c \sin B$, where the lower-case letters refer to the sides, measured in terms of the angle they subtend at the center of the sphere, and the capitals to the angle of the spherical triangle. By dissection of oblique spherical triangles into right triangles, a series of relationships analogous to the laws of plane trigonometry can be derived. M. Co.

**TRÍKKALA** [tri′kɑlɑ], the name of a department and its capital in Thessaly, Greece. The department has an area of 1,180 sq. mi. During the fighting of World War II many of its towns were damaged, especially the city of Tríkkala itself, in July 1943. Originally known as Tricca in ancient times, the city of Tríkkala is located a few miles north of the Piniós River, at the north of the Thessalian plain, 88 mi. north of Pátrai (Patras). Center of the local trade in wheat, maize, tobacco, and silkworm cocoons, the city is an important commercial town for the region's peasant farmers and Vlach shepherds (Walachians from the Pindus and Chasia mountains. Pop. 1951 (city), 23,385; (department), 127,481. S. Van V.

**TRILBY,** a novel by George du Maurier, published in 1894, is a picture of artistic life in Paris in the 1850's. Three Englishmen became enamored of a beautiful Irish model Trilby, particularly famous for her lovely feet. The girl returns the love of one of them, "Little Billee," but gives him up because she feels she is not worthy of him. Despondent, she falls into the hands of a sinister musician, Svengali, who by means of hypnosis transforms her into the greatest singer of the era. When Svengali dies, Trilby's skill vanishes; and she soon wastes away and dies, surrounded by those who have loved her. Here and elsewhere in the novel, there are echoes of Henri Murger's *La Vie de Bohème.* H. H. Wa.

**TRILL** (in older usage, *shake*), in music, the rapid alternation of a tone with the one immediately above it, usually indicated by *tr* followed by a wavy line. This form of ornamentation was developed in the sixteenth century as a means of resolving a dissonance at a cadence, and therefore always began on the higher of the two notes. Since early in the nineteenth century, the trill has been used primarily as a virtuosic effect, beginning on the main note rather than on the upper one. W. Li.

**TRILLIUM** [trɪ′liəm], a genus of low, perennial, woodland herbs of the lily family, native to North America and eastern Asia. Of the 30 or more species, about 20 are found in North America, most of them east of the Rocky Mountains. They are erect plants, varying among species from 6 in. to 2 ft. high. From the short, thick rootstocks rise simple stems, bearing at their summit a whorl of three broad leaves and a single flower. The attractive flowers, which bloom in early spring, have thin greenish sepals and three broad, spreading petals, colored white, pink, or purplish. The common names of wake-robin, birthroot, wood lily, and ground lily are sometimes given to this genus.

Among the commonest species of the eastern United States are *T. grandiflorum,* often grown in wild gardens for its handsome white flowers which fade to pink; *T. erectum,* bearing malodorous, purplish flowers; and *T. undulatum,* having wavy, white, red-veined petals. The best known western species are *T. ovatum,* having white flowers fading to pink; *T. rivale,* bearing purple markings on its white flowers; and *T. chloropetalum,* having large reddish, yellowish or white flowers, and often bearing mottled leaves. J. C. Wis.

**TRILOBITE.** *See* PALEONTOLOGY.

**TRILUSSA** [trilu′ssɑ] (1871-1950), pseudonym of the Italian dialectal poet Carlo Alberto Salustri, was born in Rome in September 1871. At the age of fourteen he began to publish in the newspapers of the Italian capital sonnets in the *romanesco* dialect. From the regional sonnet which chronicles in satirical vein everyday events in middle-class society of Rome, he progressed to a development of the Classical fable. In this he caricatures humanity in the disguise of the animal, ridiculing with smiling malice, good-natured moralizing, and pleasing impartiality the weaknesses and passions, treacheries, and self-deceptions of all the classes of Rome, giving thereby a kind of universality to his content. Among his works are the volumes *Le Stelle de Roma* (1887), *Favole romanesche* (1900), *Ommini e bestie* (1908), *Giore e le bestie* (1933), and *Cento apologhi* (1936). The definitive edition of Trilussa's work was begun by the publisher Mondadori of Milan in 1919 and, by 1946, ran to fourteen volumes. Selected translations have appeared in several languages, including English. He died in Rome on Dec. 21, 1950. D. M. S.

**TRIM, CORPORAL,** devoted servant, in Laurence Sterne's *Tristram Shandy,* of Uncle Toby, his former captain. Trim's serio-comic sermon on mortality is justly famous.

**TRINCOMALEE** [trɪ′ŋkoməli′], a city and port on the northeastern coast of Ceylon. The city has a high year-round temperature; the coolest month, January, has an average temperature of 78° F., while the warmest month, May, averages 86° F. The average annual rainfall is about 65 in., and October, November, December, and January are the rainiest months. Most of the people depend on subsistence crops, coconut groves, and fishing for a livelihood. The shallow lagoon at Trincomalee, Lake Tamblegan, is occasionally used for pearl fishing. The city has a fine natural harbor and is the terminus of a railroad line, but it is not on the main route of trade, the hinterland does not produce much for export, and the city is thus not of great economic importance. An important and well-equipped British Naval Base was established at Trincomalee during World War II, and an airfield with runways long enough for B-29's was built from which American planes carried out missions against the Japanese in Burma and Malaya. The Portuguese originally recognized the value of the harbor and established a settlement early in the 1500's, but they lost the city to the Dutch, and the British captured the city in 1795. Pop. 1943, 29,146. J. E. F.

**TRINIDAD** [trɪ′nɪdad], a British colony, and the most southerly island of the West Indies. It is situated 15 mi. off the northeast corner of Venezuela, from which it is separated on the northwest by the Dragon's Mouth, on the west by the Gulf of Paria, and on the south by the Serpent's Mouth; it is bounded on the east by the Atlantic Ocean. The island has an area of 1,864 sq. mi. Tobago, an island lying 21 mi. northeast of Trinidad, is an administrative part of the colony; it has an area of 116 sq. mi.

Trinidad is related geologically to South America but is classified as one of the West Indies. The northern mountain range of the island, a continuation of the mountains of the Paria Peninsula of Venezuela, is formed from crystalline rock overlain by sediments; the highest elevation is 3,085 ft. There is a lower range along the southern coast. The island is famous for its asphalt lake, which covers a little more than 100 acres on the southwestern peninsula. Soft pitch appears to boil continually at the center of the lake, and masses of asphalt well up and move toward the sea like glaciers. Rain water collects on the lake's surface and flows in small streams across it. The lake is the source of valuable exports of asphalt.

*PITCH LAKE, TRINIDAD. THE ASPHALT FROM THE LAKE IS SHIPPED FROM THE NEAR-BY SEAPORT OF LA BREA TO MANY PARTS OF THE WORLD.*

BURTON HOLMES FROM EWING GALLOWAY

Other mineral wealth is represented by oil reserves, which make the island the most important oil-producing colony in the British Commonwealth. The field, at the southern end of the island, is in the Tertiary beds; it came into operation in about 1911. Production of crude oil in 1946 totaled 20,232,641 barrels. The island also has coal and gypsum deposits.

Although tropical in location, Trinidad has a comparatively temperate climate. The mean annual temperature at Port of Spain, the capital, is 77.6° F. Rainfall varies with location and elevation, averaging about 50 in. annually in the extreme west and about 150 in. in the extreme northeast, in the path of the trade winds. At one time the island was almost completely covered by a tropical rain forest, but part has been cut and plantations have been established. Cacao originally was the chief crop, but it has been replaced in economic importance by sugar cane. Both are exported, as well as coconuts and nutmeg. Rum and bitters and lime oil are other export products. Most of the island's trade is with the United States, Great Britain, and Canada.

The majority of the inhabitants are natives of the West Indies, of African descent; the balance consists of East Indians, numbering approximately 214,000, several thousand Chinese, and a small number of European and American whites. Port of Spain, the headquarters of the Caribbean Commission, is the largest town, with a population in 1946 of 97,571. English is spoken generally throughout the colony. The government is headed by a governor and a colonial secretary and includes a legislative council of five nominated and eighteen elected members. Educational facilities include 262 elementary and intermediate schools (1948) and a number of high schools, convent schools, and colleges. Pop. (off. est. 1947), 558,610.

**History.** Trinidad was discovered in 1498 by Columbus, and was settled by the Spanish in about 1532. San José de Oruna, the former capital, was burned by Sir Walter Raleigh in 1595. In 1783 the island was opened by Spain to any Catholic settlers, and a large number of French refugees arrived. The British captured the island in 1797, later receiving title to it by the Treaty of Amiens, 1802. In 1921 the Imperial College of Agriculture was established at St. Augustine, attracting students from many countries. During World War II the German submarine blockade seriously affected the island's economy until, in 1941, the United States leased sites for bases. Construction of these bases under terms of a 99-year lease agreement brought higher wages and an increased circulation of money in local enterprises. On Mar. 21, 1946, universal suffrage became effective in the colony for British citizens over 21 years of age. A new constitution was announced in January 1949 which, among other things, changed the composition of the legislative council so that a larger number of the council were elected by the populace and so that the total membership numbered twenty-three, excluding ex officio members, instead of fifteen.

J. E. F.

**TRINIDAD,** a city in southern Colorado, the county seat of Las Animas Co., situated on the Purgatoire River, about 80 mi. south of Pueblo. The city was founded in 1869 and incorporated in 1879. The local government is administered by a council and manager. Trinidad is a trade center for an extensive stock-raising area. The principal industrial occupation of the residents is the mining of the coal found in the vicinity, which also has helium gas and timber resources. Transportation facilities are furnished by the Denver & Rio Grande Western, the Atchison, Topeka and Santa Fe, the Colorado and South-eastern, and the Colorado and Southern railroads. Pop. 1950, 12,204.

**TRINITARIANS,** members of the Roman Catholic Order of the Most Holy Trinity of the Redemption of Captives, founded in 1198 at Cerfroid, France, by St. Jean of Matha and St. Félix of Valois. The order had 250 houses

within a century, and in three centuries it freed some 90,000 Christians from their Moslem captors. The friars gathered alms and served as hostages. The order suffered losses in the late eighteenth century. In 1947 it counted 370 professed members, of whom 64 were in the United States. The Trinitarian Sisters were founded in 1612 in Spain by Maria de Romero. The habit is white and ornamented with a red and blue cross. Entirely distinct from the Trinitarians are two modern American institutes for social work, founded in 1929, the Missionary Servants of the Most Holy Trinity (135 priests and brothers in 1947) and the Missionary Servants of the Most Blessed Trinity (332 sisters in 1947).

W. C.

**TRINITROTOLUENE.** *See* EXPLOSIVES.

**TRINITY** (O. F. *trinité* from Lat. *trinitas,* a triad, the Trinity), the mystery of one God in three persons, the Father, the Son, and the Holy Spirit, the mystery of three distinct persons in numerically one and the same substance, nature, or essence, of which the second person proceeds from the first through true generation, the third from the first and second as from a single principle through spiration. This definition summarizes the traditional Christian doctrine of the Trinity as universally admitted before the separation of the Roman and Eastern Orthodox Churches.

Rationalists either reject the doctrine of the Trinity or radically change its meaning. Pantheists and Theosophists teach a trinity that represents an evolution of God. Conservative Protestants (notably Lutherans, Calvinists, Anglicans) profess the traditional doctrine. Modern liberal Protestants generally teach a "trinity of revelation" of purely economic character: God's common fatherhood was taught by Jesus Christ, whose spirit dwells in his followers. The Modernists regard the dogma of the Trinity as simply a Judaeo-Hellenistic theory gradually elaborated during the first four centuries after Christ.

**History of the Dogma.** It is generally agreed that the doctrine was formulated with progressively increasing clarity as its terminology developed and that it came to its full expression largely by way of correcting error or heresy. The chief steps in the history of the dogma may be briefly summarized.

*Scripture.* St. Epiphanius (d. 403) wrote: "The one Godhead is above all declared by Moses, and the twofold personality (of Father and Son) is strenuously asserted by the Prophets. The Trinity is made known by the Gospel." Theologians commonly hold that in the Old Testament there are, at most, obscure adumbrations but no distinct intimation of the Trinity, which was the object of a progressive revelation made by Christ to his Apostles and recorded in the New Testament. In various Gospel texts Catholics find the assertion of the distinct personality and the divinity of each of the divine persons; in the New Testament as a whole they find all the essential elements of the doctrine. This interpretation is rejected by liberal Protestants.

*Tradition.* The tradition concerning the doctrine of the Trinity falls into three chronological periods, spanning respectively the time before, during, and after the Arian controversy of the fourth century. Catholic theologians adduce the following arguments to prove the continuity of the Christian tradition from the earliest times: (1) the baptismal formula, (2) the ancient doxologies, (3) the formal teachings of early ecclesiastical writers, (4) the controversies with early heretical sects (Sabellians, Montanists). Certain stages may be distinguished in this tradition. The Apostolic Fathers set forth the mystery simply, the Apologists introduced some philosophical concepts in their refutation of the pagans and Gnostics, while the Fathers of the third century began a scientific exposition of the dogma against heretics who denied the divine unity or the trinity (Noëtus, Sabellius, Paul of Samosata). In brief, the ante-Nicene Fathers taught the real distinction and divinity of the three persons and the perfect unity of the Godhead; from this logically follows the perfect equality and consubstantiality of the three Persons. But in their attempts at a philosophical interpretation of the dogma, the ante-Nicene Fathers used certain expressions which would favor subordinationism. In the late seventeenth century the Socinians cited these expressions to prove that the ante-Nicene tradition agreed rather with Arius than with Athanasius; the Antitrinitarians developed this position. Catholic theologians commonly defend the orthodoxy of these early Fathers, while admitting that certain of their expressions were inaccurate and eventually dangerous.

The teachings of Arius were condemned in the first Council of Nicaea (325), which defined that the Word (the Son) is "consubstantial" with the Father. The great defender of orthodoxy against Arius was St. Athanasius (d. 373). In the first Council of Constantinople (381) the doctrine of Bishop Macedonius, which subordinated the Holy Spirit to the other persons of the Trinity, was condemned, and the consubstantiality of the Holy Spirit with the Father and the Son was proclaimed.

That the post-Nicene tradition in the West was substantially unanimous is generally admitted. Because of confusion in the understanding of the terms "nature" and "person," certain heterodox opinions were held by various individuals, and in remedy the fourth Lateran Council (1215) supplied a summary of the whole trinitarian dogma. The teaching of Photius (d. 891), that the Holy Spirit proceeds from the Father alone, adopted by the Orthodox Church after the definitive break with Rome in the eleventh century, was condemned in the West by the Councils of Lyon (1274) and Ferrara-Florence (1439).

**Theological Interpretation.** Whereas the Greek theologians in speaking of the Trinity were inclined to use analogies drawn from the external world, the Latins followed the lead of St. Augustine (d. 430), who founded the psychological theory of the Trinity by indicating the analogy between the divine processions and the human activities of thought and will. Developed, completed in detail, and perfected in terminology by the Scholastics, the theory received its classic form from St. Thomas Aquinas.

The term "Word" (Gr. λόγος, John i:1) is understood to signify the mental word or intellectual concept. The generation of the Son by the Father (Nicene Creed) is understood, then, as an act of intellectual conception necessarily producing the likeness of the object known. In God the cognitive act is identical with the divine substance; and its term, the divine Word, is subsistent and divine, the second person of the Trinity. The Holy Spirit is understood to proceed as the term of the act of the divine will, and this term too is subsistent and divine, the third person of the Trinity.

The three divine persons are coequal in substance, nature, and essence; each is God; they are indistinguishable by reason of any absolute attribute of their common divine nature. How then are they distinguished?

Latin and Greek theologians alike answered that, since in real procession the principle and the term are really related, the generation of the Son and the procession of the Spirit involve the existence in the Divinity of four real, objective, subsistent relations, whose mutual opposition constitutes the distinction between the persons. There are four such relations:

*paternitas* (fatherhood), *filiatio* (sonship), *spiratio activa* (breathing), *spiratio passiva* (being breathed); since spiration is not opposed to paternity and sonship, the four relations constitute but three persons. To those who reject revelation or consider metaphysics a mere figment of the human mind there is no value discernible in such philosophico-theological speculations. For the trinitarian theologian their value lies in the light, however feeble, they shed on what he acknowledges to be, in the last analysis, an inscrutable mystery.

**Christology.** Intimately connected, both historically and theologically, with the dogma of the Trinity is the complex of dogmatic teachings about "the Word made flesh," i.e., about the personality, nature, and operations of Jesus Christ. The basic tenets of Catholic and Orthodox Christology are three: Jesus Christ is true man; he is true God; his human nature and his divine nature are hypostatically united in the one person of the Word (the second person of the Trinity). Each of these propositions has from earliest times been bitterly opposed; each has been defended as being contained in Scripture, taught by the Fathers, defined by Ecumenical Councils; each has been developed in its theological implications and significance for Christian life; each has been subjected by Rationalists, Liberals, and Modernists to denial or attenuation.

St. Paul emphasizes Christ's share in human weakness, his sufferings, his Passion: he affirms also the divine Sonship of him "who is over all things, God blessed for ever" (Rom. ix:5). The doctrine of John i:1-14 is the foundation of John's whole theology. That the synoptic evangelists imply and anticipate the teaching of the fourth Gospel is affirmed by Catholics, denied by some Protestants. Ecumenical Councils, notably those of Ephesus (431), Chalcedon (451) and Constantinople II (553), formally affirmed the divinity of Christ and the union of his two natures in one person. The earliest Reformers retained the old teaching concerning the Incarnate Word; of later Protestants, many regard Christ as the epitome of human ideals, but only in a moral sense, not physically and consubstantially, the Son of God. *See also* ARIANISM; CREED; MONOPHYSITES; NESTORIUS; *and articles on individual councils of the Church.* N. J. T.

**TRINITY COLLEGE,** an accredited, privately controlled men's college of arts and sciences, affiliated with the Episcopal Church. It is located on a campus of 80 acres, away from the business center of Hartford, Conn. The institution started in 1823 as Washington College. The name was changed to the present form in 1845. The local chapter of Phi Beta Kappa was organized that same year. The A.B. and the M.A. are the degrees offered. Courses in pre-engineering may be elected. Dormitories are provided for students not living at home. There are chapters of several fraternities on the campus and members may live in the houses. Scholarship and fellowship offerings are generous, with more than half limited to residents of the state of Connecticut. There is also a loan fund. *For statistics see* COLLEGES AND UNIVERSITIES.

J. R. To.

**TRINITY COLLEGE,** an accredited college of arts and sciences for women, conducted by the Sisters of Notre Dame de Namur of the Catholic Church. It occupies a 35-acre campus in the suburbs of Washington, D. C. Affiliation is maintained with the Catholic University of America. First instruction was given in 1900, three years after the college was founded. Authority to grant degrees was given by act of Congress in 1935. Only the A.B. degree is offered. The well-equipped library includes special collections on Church history and John Henry Newman. Scholarship awards are generous and substantial assistance is given to foreign students. Residence halls are provided and all out-of-town students are required to live on the campus. *For statistics see* COLLEGES AND UNIVERSITIES. J. R. To.

**TRINITY RIVER,** a river in Texas 360 mi. long. It has its headwaters in the West Fork and East Fork rivers, which rise in northern and northeastern Texas and join in Kaufman Co., southeast of Dallas. The river drains a fertile and productive farming area of about 18,000 sq. mi. as it flows southeastward to enter the Gulf of Mexico through Galveston Bay. J. E. F.

**TRINITY SUNDAY,** the first Sunday after Pentecost. It was designated for general observance in the Latin Church by Pope John XXII (1316-1334). The elements of a Trinity Office for Sunday use had been assembled during the Arian controversies. The Gregorian Sacramentary (before 800) contains prayers and the Preface of the Trinity. The Micrologies of the time of Pope Gregory VII mention an office composed by Bishop Stephen of Liège (903-920) and recited in some places on the Sunday after Pentecost. Between Pentecost and Advent, the Sundays (23 to 28 in number) are by the Anglicans called "after Trinity," in the Roman calendar "after Pentecost." *See also* PENTECOST.

N. J. T.

**TRINITY UNIVERSITY,** an accredited, coeducational, privately controlled institution affiliated with the Presbyterian Church. The charter was granted in 1869. The university was situated at Waxahachie, Tex., on an 80-acre campus until 1942, when it was moved to San Antonio, Tex., and combined with the University of San Antonio. It is now housed on the latter's 107-acre campus. Degrees offered are the A.B., the B.S., the B.Mus., and the B.S. in industrial education. The library features the Ziegler Collection on the history of the Southwest and the Archives of the Presbyterian Church in Texas. Residence halls for noncommuting students have been provided. Scholarship assistance, in the form of small stipends, is available to high-school honor graduates. *For statistics see* COLLEGES AND UNIVERSITIES.

J. R. To.

**TRIO** [tri'o], a term in music having a variety of meanings. It commonly refers to any combination of three performers, either vocal or instrumental; of these, the piano trio, consisting of a piano, a violin, and a cello, and the string trio, composed of a violin, a viola, and a cello, are most frequently encountered.

A composition written for such a combination is called by the same name. The trio sonata of the Baroque period is not a true trio, however, for the three string parts were always supplemented by the harpsichord, played from the cello, or figured bass part.

In minuets, scherzos, marches, and other examples of the "song form with trio," the middle section, usually complete in itself, is also called a trio. The name arose in this case from the ancient practice of arranging the second of three dances for three instruments only. In marches and minuets, the third section, following the trio, is usually a repetition of the first part. W. Li.

**TRIODE.** *See* ELECTRON TUBES.

**TRIPLE ALLIANCE,** a defensive coalition among Germany, Russia, and Italy, which was instigated by Otto von Bismarck, chancellor of Germany. After the Franco-Prussian

war of 1870-1871, Bismarck made it a cardinal point in his foreign policy to keep embittered France isolated. Since Russia and Austria-Hungary appeared to be the two possible allies that France might bring to its side in a projected war of revenge, Bismarck spun a web of alliances which effectively blocked off France from these powers. His aim was to prevent any coalition between states to the east and west of Germany that together might crush the new German Empire. And even though Bismarck ostentatiously spoke of German "saturation" (Germany's having reached the limit of its territorial ambitions on the continent), he knew that other states suspected and feared Germany. He thought that its safety and the hope of continued peace lay not in a display of antagonizing strength, but rather in diplomatic bonds created in accord with a policy dictated by himself.

Bismarck's initial move was the formation in 1872 of the Three Emperors' League, made up of Francis Joseph of Austria-Hungary, Tsar Alexander II, and the German Emperor, William I, who committed themselves orally to the preservation of the status quo. Victor Emmanuel of Italy supported this position the next year. The League was not satisfactory to Germany, for at a threat of war with France in 1875, other powers, including Russia, intervened in behalf of France. At about the same time, rivalry between Austria-Hungary and Russia in the Balkans forced Bismarck to choose between them, and he cast his lot with Austria. His support of Austria-Hungary became more pronounced when he opposed the territorial arrangements made by Russia after the latter had defeated Turkey in 1877. This rivalry between Austria-Hungary and Russia killed the Three Emperors' League.

**The Dual Alliance.** The Austro-Hungarian foreign minister, Count Gyula Andrássy, asked for an alliance aimed at Russia. Bismarck, after exerting very great pressure on his unwilling master, Emperor William I, consummated the Dual Alliance with Austria-Hungary in October 1879. In this arrangement Austria-Hungary refused to be bound against France. The agreement of 1879 between Germany and Austria-Hungary provided that if either party were attacked by Russia or by a power backed by Russia, the other would come to its aid. Germany and its ally also agreed that if either were to go to war with any power except Russia, the peaceful ally would observe benevolent neutrality. This alliance was a milestone in European history. Earlier alliances had been organized for specific ends which, once achieved, brought an end to the alliances. Originally the Dual Alliance was to run for five years; it was renewed in 1883 and on later occasions and lasted until both parties met defeat in 1918. Emperor William's reluctance to form the alliance stemmed from his fear that it would force Russia to the side of France, but Bismarck and Andrássy were thinking of the short-term result of curbing Russia's Balkan aims.

**Triple Alliance, 1882.** The dual partnership between Austria-Hungary and Germany was enlarged to include Italy in the Triple Alliance of 1882. The provisions of the Triple Alliance stated: (1) if France attacked Germany, the latter could count on Italian aid; (2) if Italy were attacked by France, Germany and Austria-Hungary would assist Italy; and (3) if any of the three members of the alliance were attacked by two or more powers, the remaining two members were obligated to aid. Italy's adherence to this alliance, which included its traditional enemy Austria, occasioned much surprise. The usual interpretation has been that Italy's action was dictated by anger at France's assumption of a protectorate over Tunisia (1881), a region in which Italy also had ambitions. Italy seemed really to have been animated by two aims, to strengthen the secular state against the Papacy and to gain support from the "autocratic" monarchies against a rising tide of republicanism.

Bismarck was uneasy when he contemplated an isolated and resentful Russia; he hoped for a reorganization of the Three Emperors' League. This was made easier because Russia was then at odds with Great Britain over their rival aims in Asia and the Near East, and was receptive to Bismarck's prompting. Austria-Hungary was brought in and the Three Emperors' League was reconstituted in June 1881. The agreement indicated that Germany and Austria-Hungary would not aid Great Britain against Russia, and that the latter would remain neutral in a war between France and Germany or in the event of a conflict between Austria-Hungary and Italy. This agreement was renewed in 1884 but lapsed in 1887. Like some other diplomatic agreements of this period, this was kept a tight secret and was not revealed until World War I. Austria-Hungary tied to its side both Serbia and Romania by treaty arrangements, thus setting up another check to Russia's Balkan ambitions.

In 1887 Bismarck negotiated a reformulation of the Triple Alliance. This new arrangement was made up of three treaties: (1) the old treaty of 1882 unchanged; (2) a new German-Italian treaty; and (3) a new Austro-Italian treaty. Italy could now call on German aid should a Franco-Italian conflict break out over North Africa. The Austro-Italian treaty provided for the maintenance of the status quo in the Balkans and the eastern Mediterranean, or joint division of the spoils should any territorial changes in these regions occur.

The approaching dissolution of the Three Emperors' League in 1887 caused Bismarck and the Russians to seek some alternative. The Russians wanted an understanding, hoping Germany would restrain Austria-Hungary in the Balkans. Russia and Germany signed a secret "reinsurance" treaty on the day the Three Emperors' League died. In this new agreement Russian neutrality was promised in a Franco-German war; Germany was to be neutral in a war between Russia and Austria-Hungary or between Russia and Great Britain. Bismarck's diplomacy steered the German ship of state with apparent safety between Russian and Austro-Hungarian ambitions; the isolation of France was seemingly more certain than ever.

Within a few years, however, Russia suspected Germany of hampering its designs in Bulgaria. Bismarck took steps in November 1887 to prevent Russian loans from being floated in Germany. Russian finances were then in difficult straits, which gave pause to Tsarist imperialism. But while Russian sentiment hardened toward Germany, the Tsar's government turned to Paris for much needed funds.

Despite the uncertainties that marked German-Russian relations, Bismarck strove to maintain a semblance of cordiality with his powerful eastern neighbor. The reinsurance treaty was due to expire in June 1890, and the German Chancellor initiated talks to renew it. But the new German emperor, William II, and the Chancellor were an ill-matched team, and Bismarck was dismissed. His successor was Count Leo von Caprivi, who looked with disfavor upon the reinsurance treaty, which was then allowed to lapse.

**The Triple Entente.** In the following years a series of agreements resulted in the formation of a rival group of powers, the Triple Entente, including France, Russia and England. Gradually Italy, a member of the Triple Alliance, gravitated to the Entente. A succession of crises involving

antagonistic ambitions in North Africa and the Balkans sharpened the hostility between these two power-blocs. The Triple Alliance was renewed again in December 1912, with Italy apparently on good terms with her Teutonic partners. Although Italy and Austria-Hungary watched each other warily in Albania, they and Germany signed a naval convention providing that "the naval forces of the Triple Alliance which may be in the Mediterranean shall unite for the purpose of gaining naval control of the Mediterranean by defeating the enemy fleets." Following this understanding, Italy in March 1914 obligated itself to send large military contingents to aid Germany should war break out with France.

Thus, on paper, the Triple Alliance in 1914 was more tightly knit than ever, seemingly covering every military and naval contingency. But in the crisis of July of that year the bonds proved inadequate. Germany and Austria-Hungary adhered to the obligations of the Alliance, but Italy declared it was not bound by Austria-Hungary's move against Serbia, as the Triple Alliance had been violated by Austria-Hungary, which had failed to consult the Italian government, and as the Central Powers were embarked on aggressive warfare; therefore Italy was asserting its neutrality. Italy really feared the extension of Austro-Hungarian influence in the Balkans, and was especially mindful of British naval power in the Mediterranean. Italy ultimately joined the Triple Entente in World War I, but Austria-Hungary was yoked to Germany until their alliance crashed in the ruins of defeat in November 1918. *See also* TRIPLE ENTENTE. M. K.

**TRIPLE ENTENTE** [tə̄′tə̄′t], a system of alliances joining together France, Russia, and Great Britain, which was finally consummated in 1907. It was designed to counterpoise the Triple Alliance, which had been formed earlier between Germany, Austria-Hungary, and Italy. The Entente was originally born of the French need to escape the diplomatic isolation into which she had been thrust by Chancellor Otto von Bismarck of Germany in the years that followed the Franco-Prussian War of 1870-1871.

**Franco-Russian Alliance of 1894.** France felt that she could end this isolation only by alliance with powers free from German domination. The opportunity came in the late 1880's and early 1890's when Russia, aggrieved at Germany, with whom she had been secretly allied, joined France in an alliance designed to offset German hegemony on the continent. It had been made clear to the Russians that in any Austro-Russian conflict, Germany would back Austria. During a Balkan crisis in the winter of 1887-1888, which might have involved Russia in hostilities with Austria, Bismarck supported the latter with the aggressive statement that Germany was prepared to fight a war on two fronts. At the same time Russia was barred from floating loans in Germany. France seemed to be the only recourse for Russian financial needs. French failure to detach Italy from Germany and Austria, Great Britain's apparent friendliness toward the Triple Alliance, and France's fear that the British might even join the Alliance were other factors that forced an accord of the two isolated powers, France and Russia.

Prior to the agreement between France and Russia the French fleet visited Kronshtadt, a Russian naval base near St. Petersburg. Notes were exchanged between the two governments on Aug. 27, 1891, promising in rather vague terms to "confer on every question of a nature to threaten the general peace." It was stipulated further that "in case this peace should actually be in danger," and if either France or Russia should be threatened, commitments be exchanged. In 1892 the general staffs of the French and Russian armies reached an understanding, and in January 1894 a military convention was ratified. The terms of this convention, which was secret, provided that if France were attacked by Germany, or by Italy supported by Germany, Russia would fight Germany; or if Russia were attacked by Germany, or by Austria supported by Germany, France would fight Germany; and if the forces of the Triple Alliance or any one of its members were mobilized, France and Russia would immediately mobilize their own forces and move them to their respective frontiers. France and Russia also agreed that in the event of war neither would make a separate peace, and further, that the military convention should last as long as the Triple Alliance. This alliance between France and Russia, although its exact details were kept secret, was publicly announced in 1895.

The balance of military power on the Continent then seemed to be adjusted, but rivalries in Africa and Asia helped upset it. In the 1890's France and Russia were both involved in rival expansionist programs with Great Britain; Russia against Great Britain in Asia, France against Great Britain in Africa. Germany thought it to its advantage to side with the rivals of Great Britain and at the same time to secure some gain for itself. By encouraging Russia and France to engage in such imperialist ventures outside Europe, Germany expected to weaken the effectiveness of the Franco-Russian treaty as a potential threat.

**The Entente Cordiale.** The uncommitted great power in this game of balancing alliances was Great Britain. There were occasions when it leaned to the Triple Alliance, but in the first years of the twentieth century it began definitely to move to the side of the French. The British were fearful of mounting German economic power. German support of the Boers in South Africa in their conflict with the British angered Great Britain. Even more disturbing was Germany's attempt to organize a coalition to obstruct the continued expansion of the British Empire. The Reichstag passed a law which provided for a substantial increase in the German navy, so as to make it strong enough to challenge the British fleet. High German officials, who had convinced themselves that Germany was strong enough to play a lone hand, nevertheless preferred an alliance with Great Britain, but on their own terms. And their terms were high, because Germany thought that Great Britain's differences with France and Russia were too great to be surmounted. German diplomacy miscalculated; Great Britain arrived at an understanding with both France and Russia. Great Britain's first significant departure from her isolated diplomatic position was an alliance with a non-European power, Japan, in 1902. Four years earlier, in 1898, the British and the French had composed their differences in Africa, averting a conflict threatened because of the Fashoda incident in the Sudan. Théophile Delcassé, the French minister of foreign affairs, urged an alliance with Great Britain, endeavoring at the same time to woo Italy from Germany's side. By 1900 an agreement was reached providing for French recognition of Italian aims in Tripoli, while Italy recognized French expansion in Morocco. Furthermore Italy, a member of the Triple Alliance, signed a secret agreement with France in 1902 promising to remain neutral in case of a Franco-German war. The Anglo-French *rapprochement* was hurried along by King Edward VII's popularity with the French. By April 1904 an agreement had been reached. The Entente Cordiale settled territorial differences between the two powers in various colonial areas, including French withdrawal from Egypt, while Great Brit-

ain relinquished its rights in Morocco. Although this agreement ostensibly was merely a friendly disposition of rival claims outside Europe, diplomats were aware that if Great Britain and France could co-operate in other continents, they could do likewise in Europe.

**Formation of the Triple Entente.** Following these agreements, Delcassé strove to effect an understanding between Great Britain and Russia so as to round out his diplomatic edifice. The two powers were mutually agreeable. Negotiations between the Russians and British were begun in 1906, and by August 1907 an agreement was reached between them. Its most important feature provided for a division of influence in Persia, the British sphere to be in the south, the Russian in the north, and a neutral zone between them. The Russians were also given to understand that Great Britain might relax her opposition to Russian men-of-war using the straits at Constantinople. Both Great Britain and Russia were careful to assure Germany that their understanding was not aimed at her, but presumably they had Germany in mind during their negotiations. The British foreign secretary, Sir Edward Grey, said, "An entente between Russia, France, and ourselves would be absolutely secure. If it is necessary to check Germany, it could then be done."

In the early years of the twentieth century a series of crises in Africa and the Balkans tested the strength of these agreements. Italy continued to gravitate to the Triple Entente; at Racconigi in 1909 she agreed with Russia to help stabilize the *status quo* in the Balkans "to the exclusion of all foreign domination." Russian interests maintained in the Bosporus were to be favored by Italy, whose expansion in Tripoli and Cirenaica was to be sympathetically viewed by Russia. This meant that Italy and Russia agreed in opposing Austrian influence in the Balkans. From 1912 to 1914 the bonds uniting the Triple Entente were reinforced, although no formal alliance was announced. Military and naval arrangements were perfected, and more precise commitments were initiated. The two rival blocs, the Triple Entente and the Triple Alliance, maintained an uncertain peace until 1914, when they finally went to war. *See also* TRIPLE ALLIANCE. M. K.

**TRIPOLI** [trĭ′poli] (*Arab.* Tarabulus esh Sham), a city on the northern coast of Lebanon, 43 mi. northeast of Beirut. The city is situated on a small rocky promontory of the narrow coastal plain backed by the Lebanon Mountains. Its history is similar to that of other Levantine cities. Founded probably in the seventh century B.C., it was the capital of the Phoenician federation including Sidon (Saïda), Tyre (Sour), and Aradus (Arwad). It was enlarged by the Seleucids and Romans and then taken by the Moslems in A.D. 638. Besieged for five years during the Crusades, it was taken by Raymond de St. Gilles, Count of Toulouse, in 1109 and the great library founded by the ruling family was destroyed. The city was laid waste by the Egyptian Sultan Kalaun in 1289. Later a part of the Turkish Empire, Tripoli was liberated by General Allenby in 1918, and in 1920 it became part of the Grand Liban. During World War II, it was occupied by the English and the Free French in 1941 and in the same year joined the Republic of Lebanon. The ruins of an old Turkish fort are immediately inland from the city, and there is an American School.

The climate is Mediterranean, with long, hot, dry summers and short, cool, wet winters. The average annual temperature is 69° F., with a January average of 56° F. and an August average of 82° F. The average annual rainfall is 39 in. Vegetation is semiarid, and agriculture is limited by the hot, dry summers and the small amount of level land. Wheat, millet, vegetables, tobacco, olives, and citrus fruits are grown. Industries include soap manufacture and sponge fishing. Oranges, eggs, and cotton are exported. Tripoli is the terminus of the oil pipe line across the Syrian desert from Iraq. There are an oil-tank depot, a pumping station and equipment to load tankers that anchor off shore, and a refinery. When the production at Haifa was disrupted in 1948, the economic importance of Tripoli was increased. Pop. 70,842. J. E. F.

**TRIPOLI** (*Arab.* Tarabulus el Gharb), the capital of Libya and chief port of Tripolitania, the ancient Oea of Phoenician origin. With the decline of Sabrata and Leptis Magna, the capital, known as Tripolis ("Three Cities"), increased in importance, aided by its position as terminus of one of the chief overland routes from the Sudan and central Africa. At Tripoli a line of low rocks extends several hundred feet out into the Mediterranean, providing moderate protection for ships on a coast noted for its lack of good harbors. This port came successively under the rule of Carthage, Rome, the Vandals, the Byzantine Empire, the Arabs, Spain, the Knights of St. John, the Ottoman Empire, and Italy. Almost destroyed during the seventeenth and eighteenth centuries by French and English fleets, as reprisal for the acts of its pirates, Tripoli was blockaded by the United States fleet in 1804, in an effort to end piracy in the Mediterranean. During World War I, it was one of the few places in Tripolitania held by Italian forces. In World War II, it suffered considerable damage, was captured by British forces on Jan. 23, 1943, and became the seat of the British Military Administration.

Tripoli lies in a narrow oasis of about 19 sq. mi., beyond which stretches the desert. The old section of the city is near the port and is mostly occupied by Arabs. The rest of the city, lying to the south and east, is mainly modern. Among the important buildings are the Castle or Citadel, begun on the site of an older fortress in 1535 by Georg von Schilling of the Knights of St. John; the Pasha or Karamanli Mosque, founded in 1740 by the native chief who brought Tripolitania some measure of independence from the Turks; the Gurgi Mosque (1833); and a Roman triumphal arch dated A.D. 163.

The industry of the city includes artillery and tobacco factories, saltworks, and a brewery. There are railroad connections with Zuára (74 mi.) and Garian (60 mi.), and a network of roads connects Tripoli with other cities of the province. There are steamships to African and European ports, and there is international air-line service. Pop. 109,000. *See also* TRIPOLITANIA. R. G. W.

*HISTORIC CASTLE IN TRIPOLI, LIBYA*

EWING GALLOWAY

**TRIPOLITANIA** [trɪ′polɪte′nyə; tripolitɑ′nyɑ], the northwest province of Libya, formerly an Italian colony in North Africa. With an area of approximately 156,333 sq. mi., it is bounded by the Mediterranean Sea on the north, Cyrenaica on the east, Fezzan on the south, and Algeria and Tunisia on the west. Originally the three Phoenician coastal cities of Leptis Magna, Oea, and Sabrata, of which Oea in the center was the capital, were known as Tripolis ("Three Cities"). Under the influence of Carthage until its fall, Tripolitania came under Roman rule in the second century B.C. Conquered by the Vandals in the fifth century A.D. and by the Byzantine general Belisarius in the sixth, in the seventh century the region was overrun by Arabs from Egypt. After 670, Tripolitania remained under Arab rule, sharing the fortunes of Tunisia, except for brief periods of occupation by the Normans (1146-1158), the Spaniards (1510-1530), and the Knights of St. John (1530-1551), and a short independence under local rulers (1354-1369). In 1551 it was established as a vassal state to the Ottoman Empire and became an active center of piracy. The native Karamanli Dynasty, established in 1711, was overthrown during a civil war in 1835, and Tripolitania was made a vilayet of the Turkish Empire. In 1911 Italy occupied eight coastal cities, and by the Treaty of Ouchy in 1912 Turkey ceded the rest of Libya to Italy. The country was in a state of revolt during World War I, but the Italian governors restored order and brought a considerable degree of progress and prosperity. The region was much fought over during World War II, Libya becoming a trusteeship of the United Nations after the war, with Tripolitania under British rule. Libya became an independent kingdom on Dec. 24, 1951.

Along the coast from Misurata to Zuára there are intermittent and narrow strips of oases. Inland, steppes shade off rapidly into a desert zone of sand, gravel, and rock. A line of hills, the Gebel Nefusa, lies inland roughly along 32° N. lat. The climate is dry and hot, but with seasonal variations in temperature, depending largely on the direction of the wind. When the *ghibli,* or sirocco, blows from the desert, temperatures at Tripoli on the coast may reach above 110° F. The average annual rainfall on the coast is 14 in., which decreases inland. There are no permanent streams.

In view of these conditions, Tripolitania produces little and has only a sparse population, though it has the highest density per square mile in Libya. Between World Wars I and II, Italian immigration was encouraged and a great deal of money was spent in an effort to create Italian farming communities, either directly or through concessionaires. Wells were sunk, roads were built, and shifting sand dunes were immobilized and afforested with acacia, poplar, and pines. However, it was found that without heavy and continuous subsidy the colonists returned to Italy or moved into the near-by cities. The chief products of the region are wine, tobacco, olive oil, castor oil, fruit, vegetables, cereals, alfa grass, henna, sponges, tunny fish, salt, and silkworms. Exports consist of wool, hides, salt, sponges, fish, olive oil, cereals, vegetables, and fruit.

Along the coast and in the Gebel Nefusa there is an extensive network of highways. There are railroad lines from Tripoli through Zauia and Agelat to Zuára on the west and to Tagiura on the east, as well as inland to Azizia. The chief cities and towns are Tripoli, Misurata, Homs, and Zuára, all along the coast. Pop. 1951, 768,600. R. G. W.

**TRIPTOLEMUS** [trɪptɒ′ləməs], in Greek mythology, the son of Celeus, king of Eleusis, and Metaneira; according to others, the son of King Eleusinus. In some legends, he is the inventor of the plough and the discoverer of agriculture, to whom Demeter gave a chariot with winged dragons to enable him to carry the art of corn planting to other lands. On his return to Attica, Triptolemus established the worship of Demeter at Eleusis. *See also* DEMETER. G. E. D.

**TRIPURA** [trip′ura], a state in the Republic of India, touching Assam in the east and otherwise surrounded by East Pakistan. Its 4,032 sq. mi. are mostly hilly and covered by jungle. Rice, jute, and cotton are raised in the west, and timber, tea, and fruit are grown in the hills. The capital is Agartala, near the Pakistan border. Governed by a Chief Commissioner and an electoral college, Tripura is strategically important because of its common boundary with Pakistan; from 1946 to 1951 it received more than 100,000 Hindu refugees. Pop. 1951, 639,029. R. D. L.

**TRISACCHARIDES.** *See* SUGAR CHEMISTRY (*Oligosaccharides*).

**TRISECTION OF AN ANGLE.** *See* GEOMETRY.

**TRISSINO, GIOVANNI GIORGIO** [tri′ssino] (1478-1550), Italian author, was born at Vicenza, July 8, 1478. He was associated as courtier and man of letters with various courts of northern and central Italy, and with Popes Leo X and Clement VII. He died at Rome, Dec. 8, 1550.

Trissino was one of the outstanding exponents of Hellenism in the Italian Renaissance, attempting to write works in Italian in the manner of the Greek drama and epic and following the precepts laid down in Aristotle's *Poetics.* His *Sofonisba,* finished at Rome in 1515, was a tragedy on the Greek model containing a chorus and observing the unities of time and action. *Italia liberata dai Goti* ("Italy Delivered from the Goths") was a similar effort in the field of the epic. Completed in 1547 after twenty years of labor, the poem was modeled on the *Iliad* and dealt with the war between the armies of Belisarius and the invading Goths.

Trissino also attempted to Hellenize the Italian language, going so far as to propose that certain Greek letters be introduced into the Italian alphabet. His view on the question of language in general, expressed in *Il Castellano* (1529), was that the speech of the learned and aristocratic classes, purged of regional peculiarities and ennobled by contact with the two Classical tongues, should be adopted as standard Italian in preference to Tuscan. G. R. S.

**TRISTAN DA CUNHA** [trɪ′stan də ku′nyə], a small group of volcanic islands in the South Atlantic Ocean about midway between Capetown and Cape Horn at 37° 6′ S. lat. and 12° W. long. They were discovered and named by the Portuguese in 1506. Long used as a port of call by Antarctic whalers, they were first occupied in 1810 and annexed by the British in 1816, although the garrison was withdrawn in 1817. Since 1938 the islands have been administered by St. Helena, and the inhabitants, over 100 in 1950, although highly inbred, are exceptionally healthy and long-lived. W. M. W.

**TRISTAN UND ISOLDE** [trɪ′stɑn ʊnt izo′ldə], a music drama in three acts by Richard Wagner, suggested by the thirteenth-century epic poem by Gottfried of Strassburg, which recounts the story of Tristram and Iseult. It was first performed on June 10, 1865, in Munich, Hans von Bülow conducting, although written between 1857 and 1859, when Wagner interrupted his work on the *Ring* cycle in the hope of creating a work easier to produce. *Tristan,* however, also presented difficulties for the opera houses of the time,

and the work was not produced until King Ludwig of Bavaria provided Wagner with almost unlimited facilities.

The music drama calls for only two principals, Tristan and Isolde. Tristan (tenor), a young knight at the court of King Mark of Cornwall (bass), has been sent to escort the King's intended bride, Isolde (soprano), from Ireland. On the return voyage, Isolde, who is both in love with Tristan and angered at his taking her to King Mark, resolves that both of them shall die. Consequently she prepares a poison potion for them both. Her nurse, Brangaene, substitutes a love philter, however, and the lovers are inspired with an irresistible passion for each other. The marriage to King Mark cannot be prevented, but neither can their love be quenched, and when Tristan resists the attempt of King Mark's knights to take Isolde from him, he is fatally wounded. He is borne to his own castle, but although Isolde comes to nurse him he does not survive the joy of seeing her again. Isolde dies of grief as King Mark, who has been told of the potion, arrives with his forgiveness.

The desire for fulfillment of love in death motivates the opera; the long-continued and unresolved chromatic passages, according to the composer, closely parallel the hopeless longing of the lovers. This feeling is partly the influence of Schopenhauer's philosophy upon Wagner, but it is perhaps worth noting also that during the composition of *Tristan* Wagner was in love with Mathilde Wesendonck, the wife of one of his closest friends, and derived some *Tristan* material from his settings for some of her poems.

*Tristan und Isolde* and *Die Meistersinger* are usually considered the most satisfactory of the Wagnerian music dramas in the sense that in them the musical form is clearest and the text and action most direct, so that the unity Wagner strove for is most nearly achieved. One tragic, the other comic, they stand at the peak of accomplishment of a Romantic era which was single-mindedly devoted to the expression of feeling through music. S. C.

**TRISTRAM,** a legendary hero whose origins have been traced to Scandinavian and Celtic sources. According to the main line of the many stories told of him, the noble Tristram is kidnapped from northwest Britain by pirates and carried off to Cornwall. After making his way to the court of his uncle, King Mark, he is sent to Ireland to bring back Iseult as a bride for King Mark. On the voyage back, Tristram and Iseult drink by mistake a potion that makes them eternal lovers. After reaching Mark's court, Tristram flees to France and, believing himself forgotten, weds Iseult of Brittany. Wounded by a poison arrow, he sends for Iseult of Ireland, arranging that the returning ship carry a white sail if she is on it, a black one if she is not. His wife, hearing of the plan and seeing a white sail approaching, tells Tristram that it is black. He despairs, and Iseult arrives too late to save her lover. She lies down beside him and dies also. Thomas Malory, Matthew Arnold, Richard Wagner, Edwin Arlington Robinson, and others have written different versions of the Arthurian legend.

**TRISTRAM SHANDY,** a novel by Laurence Sterne, originally published in nine volumes between 1759 and 1767. Deliberately without plot, the novel progresses by a series of lively scenes, comic and sentimental, interrupted by Sterne's dramatic monologues. Tristram Shandy is not even born until the third volume, the dominant characters being his father, Walter, and his Uncle Toby, totally unlike except in mutual devotion. Sterne ranges from broad and vulgar humor to delicate comedy. W. B. C. W.

**TRITON** [trai′tən], in Greek mythology, the son of Poseidon and Amphitrite, usually represented with a trumpet made from a sea shell. With this trumpet he aroused or soothed the waves at Poseidon's command. When Misenus, Aeneas' trumpeter, challenged him to a contest, Triton hurled him into the sea. Triton was a merman, human from the waist up, fish-shaped from the waist down. Some writers refer to the existence of numerous tritons. G. E. D.

**TRITONE.** *See* Musical Terms.

**TRIUMVIRATE** [traiʌ′mvirət], a governmental board in ancient Rome composed of three members. There were, for example, the III *viri capitales* who served as police magistrates, or the III *viri monetales* who were connected with the mint. Better known, however, are the so-called First and Second Triumvirates which exercised political power in Rome in the first century B.C. The First Triumvirate was an extraconstitutional body which came into existence in 60 B.C. when Caesar, Pompey, and Crassus formed a coalition based upon a private agreement. By combining their political forces, these unofficial triumvirs were able to control Rome as effectively as if they had legal sanction for their position. The Second Triumvirate, on the other hand, was actually established by a law of 43 B.C. which made Octavian, Antony, and Lepidus III *viri reipublicae constituendae* for a period of five years; in 38 B.C. their powers were extended for another five years. In reconstituting or restoring the Republic after the civil wars following the death of Caesar, the Second Triumvirate was granted powers which made the board superior to the ordinary magistrates of Rome. They directed foreign policy, managed taxation and finance, but did little toward the restoration of the Republic. T. B. J.

**TRIVANDRUM** [triva′ndrəm], the capital of Travancore-Cochin State in southwestern India, near the Malabar Coast. The city is situated on a low coastal plain and has a hot and humid climate. The district produces rice, coconut palm, spices, betel nuts, and rubber. Teak, bamboo, and ebony grow in the forests where there is an extensive game preserve. Handicrafts include weaving and ivory carving. Trivandrum is a university center with about 15 colleges and is noted for its ancient fort and palace and its great temple to Vishun. Pop. 1951, 186,931. J. E. F.

**TRNOVO.** *See* Turnovo.

**TROADES (THE TROJAN WOMEN)** [tro′ədiz], one of the best tragedies of Seneca, the Roman tragic dramatist of the first century A.D. The *Troades* portrays the sufferings of the Trojan women taken captive by the Greeks after the fall of Troy. The plot is twofold and concerns both the sacrifice of Polyxena, daughter of Hecuba and Priam, demanded by the ghost of Achilles as his due, and the execution of Astyanax, son of Hector and Andromache; the impact of the two deaths upon the sorrowing Hecuba serves to unify the plot. The characterizations of Agamemnon and Pyrrhus are unusually effective, and the scene in which Andromache attempts to conceal her child Astyanax from Ulysses is perhaps the most moving and dramatic scene in all Senecan tragedy. The play was modelled upon Euripides' *Hecuba* and *The Trojan Women,* with possible influences from earlier Roman tragedy. G. E. D.

**TROELS-LUND.** *See* Lund, Troels Frederik.

**TROGIR.** *See* TRAÙ or TROGIR.

**TROGON** [tro′gɒn], any one of a number of species of nonsinging birds not closely allied to any other living group. They are characterized by weak wings and feet, a relatively long tail, and a wide mouth fringed with recurved bristles; their plumage is remarkable for its soft and loosely seated feathers. They inhabit tropical and subtropical regions around the world, excepting Australia, New Zealand, and the oceanic islands; one species, the coppery-tailed trogon, *Trogon ambiguus* (11¾ in. long), crosses the Mexican border into extreme southern Arizona. Trogons wear such brilliant hues as carmine, pink, and yellow, and metallic greens, blues, and violets; the sexes are usually differently colored. They live in forested country and feed on fruits and caterpillars, which, despite their feeble powers of flight, they take mainly on fluttering wings. All lay their white or bluish-green eggs in hollow trees. The best-known species is the famous quetzal of the New World tropics, the national bird of Guatemala. *See also* QUETZAL. H. G. De.

**TROILUS AND CRESSIDA** [trɔi′ləs, krɛ′sɪdə] (1602), one of the most problematic of Shakespeare's plays, was probably written for a special private performance. It sets the love story of Troilus against the background of the Trojan war. In the development of this theme Shakespeare follows a convention established since Chaucer's day, and degrades Cressida into a worthless wanton, distributing her favors to Greek and Trojan alike. The characters of Greeks and Trojans are drawn rather in accordance with medieval conceptions than with the Homeric originals. One of them, Thersites, borrowed from Chapman's translation of the *Iliad,* is the most foul-mouthed rogue in Shakespeare's plays; his running commentary on the war reduces it to a struggle to regain a cuckold's whore. The play is loaded down with long philosophical and ethical harangues, but among these are passages of grave and noble poetry. T. M. P.

**TROILUS AND CRISEYDE** [trɔi′ləs, krɪse′də], a long narrative poem in five books by Geoffrey Chaucer, written about 1385. Troilus, son of King Priam of Troy, second only to Hector in martial prowess, after a prolonged courtly wooing, wins the love of Criseyde, daughter of Calchas, a traitor to Troy who has fled to the Grecian camp. In an exchange of prisoners she is returned to her father and, unfaithful to Troilus, accepts the Greek Diomede as her lover. Chaucer based his story on *Il Filostrato,* a poem by the Italian, Boccaccio. His poem, in turn, is the principal source of Shakespeare's play *Troilus and Cressida.* R. K. R.

**TROIS MOUSQUETAIRES, LES** [lɛ trwa′ mu′skə-tɛ′r] **(THE THREE MUSKETEERS),** one of the most popular historical novels of all times, was published in 1844 under the name of Alexander Dumas père, who had the collaboration of Auguste Maquet. The story is based principally upon the so-called *Mémoires de M. d'Artagnan* (1701-1702) by Gatien de Courtilz de Sandras. It relates the stirring adventures of three of Louis XIII's musketeers, Athos, the type of perfect gentleman, Porthos, the personification of physical strength, Aramis, half-priest, half-soldier, and the impetuous but wily Gascon cadet, D'Artagnan, all united by the immortal device, "All for one, one for all." The plot, rapid, natural, humorous in parts, always life-like, relates how the musketeers thwarted Cardinal Richelieu's attempt, through the agency of the infamous Milady de Winter, to expose the love of Queen Anne of France for the Duke of Buckingham. Milady, after poisoning beautiful Mme Bonacieux, the mistress of D'Artagnan, is finally captured, tried, and beheaded by the musketeers. R. A. P.

**TROIS-RIVIÈRES** [trwa′ ri′vyɛ′r], a port city and the county town of St. Maurice Co., Quebec, Canada, at the confluence of the St. Maurice and the St. Lawrence rivers, 87 mi. northeast of Montreal on Highway 2. It is connected by bridges across the St. Maurice River with Cap de la Madeleine. Transportation is provided by the Canadian Pacific and the Canadian National railways. Its harbor has 7,400 ft. of berthing space, a 2,000,000 bushel elevator, and a large coal dock. The harbor is open for eight months each year. There are large pulp and paper mills, various textile factories, rolling mills, and glove and footwear factories in the city, which was founded as a fur trading post in 1634. In 1737 blast furnaces to reduce iron ore were set up near by, and nails and kettles and stoves were manufactured. From 1850 to 1900 it was the outlet for lumber from the St. Maurice Basin, and during the twentieth century it has become one of the foremost pulp and paper towns in Canada. Pop. 1951, 46,074. D. F. P.

**TROJAN HORSE,** in Greek legend, the wooden horse constructed by Epeus to enable the Greeks to enter Troy. After trying unsuccessfully for ten years to capture the city by force, the Greeks resorted to stratagem. They pretended to sail away and left on the shore a huge horse filled with armed men. While the Trojans were examining the horse, Sinon, a Greek, put in an appearance and was captured posing as the victim of Odysseus' hatred; he told them that the horse was an offering to Athena and that it would bring disaster to the Greeks if taken into the city. When Laocoön, a priest of Poseidon, advised the Trojans against dragging the horse inside the wall, two huge snakes appeared and overpowered both Laocoön and his two sons. The Trojans were convinced, both by Sinon's lies and by the prodigy of the snakes, and pulled the horse into the city with songs and festivity. That night Sinon let out the armed men enclosed in the horse's body, the gates of the city were opened to the rest of the Greek forces, and the city was captured and burned. *See also* TROJAN WAR. G. E. D.

**TROJAN WAR,** in Greek legend, the ten-year war waged by the Greeks under Agamemnon for the recovery of Helen, the wife of Menelaus. The tradition probably reflects a real war between the Achaeans and the inhabitants of the Troad, which resulted in the capture and destruction of Troy in the early twelfth century B.C. The legendary accounts traced the origin of the war to the marriage of Peleus and Thetis, on which occasion Eris, the goddess of Discord, angered at not being invited, threw among the guests a golden apple, inscribed "To the Fairest." Hera, Athena, and Aphrodite each claimed the apple, and the decision was left to Paris, the son of King Priam. Paris, who was then a shepherd on Mount Ida, awarded the prize to Aphrodite, who had promised him in return the fairest woman on earth as his wife. Later he visited Menelaus, king of Sparta, and met Helen, who was the destined gift; aided by Aphrodite, he then persuaded Helen to escape with him to Troy.

Menelaus at once called the kings of Greece to his aid, and a great expedition was assembled at Aulis under the leadership of Agamemnon, king of Mycenae and brother of Menelaus. Their departure, however, was delayed by a calm sent by Artemis, who was angry with Agamemnon for slaying a

stag sacred to her. Appeasement of the goddess required the sacrifice of Iphigenia, the daughter of Agamemnon, but at the moment of sacrifice Aphrodite substituted a deer for the maiden and carried off Iphigenia in a cloud to the land of the Taurians.

The wind was now favorable and the fleet sailed to Troy. Upon its arrival, the first Greek to perish in battle was Protesilaus, who was slain by Hector. The Greek heroes greatly outnumbered the Trojans and included Achilles, Diomedes, the two Ajaxes, Idomeneus, Odysseus, and Nestor; Philoctetes, the possessor of Heracles' bow and poisoned arrows, had been left behind on the island of Lemnos with an infected foot, the result of a snake-bite. On the Trojan side the chief warriors were Hector, Paris, and Aeneas, and also Sarpedon and Glaucus, who had come as allies from Lycia.

The first nine years of the war were uneventful. Thereafter, however, the withdrawal of the wrathful Achilles from battle, as related in Homer's *Iliad,* resulted in a Trojan advance to the ships and in the death of Achilles' friend Patroclus. This moved Achilles to return to battle, with the result that the Trojans were repulsed and Achilles avenged his friend by slaying Hector. When additional allies came to help Troy, Achilles slew their leaders also, Memnon, king of Ethiopia, and Penthesilea, queen of the Amazons. But the Greek hero was not destined to see the fall of the city, for Paris, aided by Apollo, wounded him fatally in the heel with a poisoned arrow. His armor was claimed by both Odysseus and Telamonian Ajax, who committed suicide in rage and madness when the arms were awarded to Odysseus. Then, since Troy could not be taken without the aid of Achilles' son Neoptolemus (Pyrrhus), and the arrows of Heracles, Neoptolemus was summoned, and he and Odysseus (or Odysseus and Diomedes) induced Philoctetes to bring Heracles' weapons to Troy. Paris, wounded by Philoctetes, appealed for aid to Oenone, whom he had abandoned for Helen; but she refused to heal the wound, and Paris died.

In the end, the city was captured and burned by the Greeks through the stratagem of the wooden horse. King Priam was slain by Neoptolemus, and few other Trojans survived. One of these was Aeneas, who was under divine instructions to rule over the remnants of the Trojans; he escaped from the burning city with his father Anchises and his son Ascanius, but his wife Creusa was lost. Of the Trojan women, many were allotted to the Greek leaders as captives; Cassandra fell to the lot of Agamemnon, Queen Hecuba went to Odysseus, Andromache was taken by Neoptolemus, and Polyxena, the daughter of Priam, was claimed by the ghost of Achilles as his prize and was slain on his tomb. Fearing that Astyanax, the son of Hector and Andromache, might grow to manhood and seek vengeance on Greece, the Greeks killed him by throwing him from the walls of Troy. Menelaus regained possession of Helen and ultimately arrived home in Sparta after being driven by storms to Cyprus, Phoenicia, and Egypt. Agamemnon returned to Mycenae, where he was slain by his faithless wife Clytemnestra. The most famous "return" was that of Odysseus, whose wanderings and arrival in Ithaca ten years later are related in Homer's *Odyssey. See also* AENEID; ILIAD, THE; ODYSSEY, THE; TROJAN HORSE. G. E. D.

**TROJAN WOMEN, THE,** a tragedy by Euripides, presented in 415 B.C. As the play begins, Troy, for ten years besieged by the Greeks, has fallen. The plot consists of the pathetic incidents that occur on the morning of the Greek departure, and attention is centered upon what befalls the women and children of the conquered. The main characters are Hecuba, the widowed queen of Troy; her daughter Cassandra, virgin priestess and destined concubine of the Greek Agamemnon; her daughter-in-law Andromache, Hector's wife, whose little son is taken from her to be thrown from the city's walls; and the Greek adulteress, Helen, the cause of the war. The focal point and unifying force of the drama is Hecuba, who is both an individual sufferer and, together with the chorus of Trojan women, the symbol of the suffering of the mother city itself. The play is one great lyrical lamentation from the lips of the vanquished and victimized and becomes one of the most powerful indictments of war ever presented. S. D. At.

**TROLLEY BUSSES,** electrically-propelled urban passenger vehicles, designed to run on pavement instead of on rails. The trolley bus is a relative newcomer, for, although experimental models were tried early in the twentieth century, the modern type was introduced in 1928. Its electrical features resemble those of the streetcar, whereas its chassis and body are almost identical with those of the motor bus. The seating capacity of most trolley busses built after 1936 is 40 to 45.

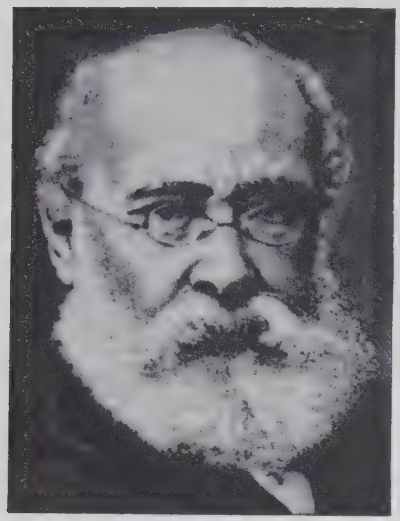
Direct current at 600 volts is taken from two parallel overhead contact wires by under-running contact shoes in swiveling heads at the ends of a pair of trolley poles with swiveling bases, mounted on the roof. The trolley bus can digress from a central position 12 to 15 ft. to stop at the curb and to pass obstructions such as double-parked vehicles.

Normally, one series-wound or compound-wound electric motor mounted under the body drives the rear wheels through a shaft and differential gear as in a motor bus. Braking is regenerative or dynamic, as in most modern streetcars. The controller, usually of the cam type, is beneath the body. Controller and brake are pedal-actuated. Acceleration and braking rates of 3.5 to 4 miles per hour per second, combined with maximum speeds of 30 to 35 m.p.h., are usual. *See also* ELECTRIC TRACTION; MOTOR VEHICLES (*Busses*); STREETCARS, ELECTRIC. M. Bu.

**TROLLOPE, ANTHONY** [trɒ'ləp] (1815-1882), English novelist, was born Apr. 24, 1815, in London. His father, Thomas Anthony Trollope, an impractical man, the author of an unfinished *Encyclopedia Ecclesiastica,* died in Belgium in exile for his debts; his mother, Frances Milton Trollope, turned to literature in an attempt to provide some sort of income. After a trip to America in pursuit of a rather ill-conceived scheme to open a department store in Cincinnati, she had made her fame with her *Domestic Manners of the Americans* (1832) and had followed this work with an endless succession of novels. The son Anthony had consequently a tempered inheritance of literary failure and success, an inheritance that he shared with the lesser talent of his brother, Thomas Adolphus.

The loneliness of Anthony Trollope's early years sprang from several causes: the stern aloofness of his father, the busy preoccupation of his cheerful mother with her own affairs, the desolate three years at Winchester School, beginning in 1827, and the dreary time spent at Harrow. In 1834, some time after the family had fled to Belgium because of the father's debts, his mother's influence procured for Trollope the offer of a job in the General Post Office in London. The position influenced his later work, for when Trollope became a successful author, he became so as a sort of lesser Chaucer, as a man who noticed the small gestures and habits and features of his characters, and through all of these indicated surely their personalities. He later perfected

his technique so that he could extend it in imagination; for his most famous figures, his Church of England clergy, seem to arise from nice observation, and yet, in the words of Trollope himself in his *Autobiography,* "My archdeacon, who has been said to be lifelike . . . was, I think, the simple result of an effort of my moral consciousness . . . as far as I can remember, I had not then even spoken to an archdeacon." The careful and curious examination of human



ANTHONY TROLLOPE

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nature that time and circumstance made possible for Trollope during his time in London bore fruit in his most successful works.

Seven years after Trollope had taken his junior clerkship in the General Post Office in London, he was made Deputy Postal Surveyor, stationed at Banagher in Ireland; three years later, in 1844, he married Rose Heseltine. During his years in Ireland there came the beginning of that prolific output of novels that characterized Trollope for the rest of his life.

In 1847, his first novel, *The Macdermots of Ballycloran,* was published, and it was followed in 1848 by the *Kellys and the O'Kellys,* both of which, as well as his next novel, *La Vendée* (1850), were pot-boilers. With *The Warden* (1855) Trollope started the series that made his fame, a group of novels whose setting was the imaginary cathedral town of Barchester in the imaginary county of Barset, and whose chief characters were clergymen of the Church of England, viewed socially rather than as religious figures, their failings looked at with sympathy and usually with good-natured amusement, their natural virtues and gentlemanly manners applauded. In addition to *The Warden,* the *Chronicles of Barset* consisted of the following novels: *Barchester Towers* (1857), *Doctor Thorne* (1858), *Framley Parsonage* (1861), *The Small House at Allington* (1864), and *The Last Chronicle of Barset* (1867). For the rest of his life, Trollope continued to pour out a continual succession of novels, short stories, travel books, and essays on an infinite number of subjects. His literary output was prodigious; but his fame still rests on his Barsetshire novels and some of his excellent novels dealing with the English political scene, the best of which are *Phineas Finn* (1869), *Phineas Redux* (1876), and *The Eustace Diamonds* (1873). Except for frequent trips abroad, many of them made for the English postal authorities, Trollope spent his creative years in England. He died in London on Dec. 6, 1882.

Trollope's *Autobiography* was published posthumously in 1883. His frank statement that he had written for money and had planned his literary production with mechanical precision was considered by many Victorians to cancel out anything that they had once thought great in him, and his literary reputation fell suddenly. In the twentieth century, however, a realization of his high reasonableness has substituted fame for Victorian popularity and has given him a secure place among the lasting English novelists.

J. H. W.

**TROMBETTI, ALFREDO** [trombe′tti] (1866-1929), Italian linguist, was born at Bologna on Jan. 6, 1866. Granted a stipend by the Municipio of Bologna, which enabled him to receive a doctoral degree in 1891, he taught in the *Licei* until 1904, when, after receiving a prize from the Accademia dei Lincei, he was appointed ordinary professor of Semitic philology in the University of Bologna. In 1921 he became a member of the Italian Academy.

Trombetti's scholarly efforts were directed almost exclusively toward discovering genealogical connections between the various linguistic families of the earth. In 1905 he published *L'unità d'origine del linguaggio,* in which he first presented his famous theory of the "monogenesis" of language, that is, the common origin of all the languages of the world. This theory, which occasioned violent polemics, was further developed in Trombetti's three-volume *Saggi di glottologia generale comparata* (1908-1920) and his *Elementi di glottologia* (1922-1923).

Judgments on Trombetti's work are generally extreme and are often vitiated by intense partisan emotions. He is regarded by some as a self-taught amateur, with more taste for rapid syntheses and broad generalizations than for the methodical and careful spadework of the well-trained scholar. There is no doubt, moreover, that his works abound in gross mistakes of every kind, which his critics were not slow to point out. However, some of his main ideas on the connection between languages (e.g., the relationship between Sandawe and Hottentot) have now been accepted by all, and it appears that others are gaining increasing favor. He did valuable work on the Algonquin and Bororoan languages, and his book *Saggio di antica onomastica mediterranea* (1925) is also important. Mussolini praised his studies in Etruscan, especially *La lingua etrusca* (1928), but these are among his weakest publications. Trombetti died at the Lido, Venice, on July 5, 1929.

G. B.

**TROMBONE** [trɒ′mbon; trɒmbo′n], a musical instrument consisting of two parallel metal tubes, one beginning in a cup-like mouthpiece, the other ending in a flaring bell; connecting the two is a sliding tube which shortens or lengthens the total length of the tubing, raising or lowering the fundamental tone together with the seven or eight overtones regularly obtained. The trombone is thus not only fully chromatic throughout nearly three octaves, but also, unlike any other wind instrument, it can easily produce a portamento, or "smear," from one end of its range to the other. Properly played, the trombone can be smoothly articulate as well as solemn and stentorian. In American popular music it croons and sobs, often with the aid of various appliances known as mutes, which may be stuffed in the lower end of the instrument to muffle or otherwise alter the tone.

Unlike other modern orchestral instruments, the trombone has changed very little in structure or manner of playing since it first appeared in Europe during the fifteenth century. For several centuries it was the only lip-blown wind instrument possessed of a complete chromatic scale, and for that reason it was important in art music when horns and trum-

pets were still chiefly military signal instruments. In church music, at court ceremonies, and in municipal bands the trombone was a valued instrument until the nineteenth century, when it lost its old position only to gain a new and permanent place in orchestral and military band music.

Like most other wind instruments, the trombone has been constructed at times in a variety of sizes, ranging in pitch from soprano to contrabass. In modern orchestras and bands, however, only the tenor and bass trombones are common. It is the tenor which serves on occasion as a solo instrument, and which has played an integral part in American popular music since the days of minstrel bands. Valve trombones, with valves replacing the slide, have been tried without lasting success. W. Li.

**TROMP, MAARTEN HARPERTSZOON** [trɔ′mp] (1597-1653), Dutch admiral, was born in 1597 in Brielle, South Holland. He went to sea as a boy and was captured by the British, who held him prisoner aboard ship for several years. On escaping he entered the Dutch navy and was made lieutenant admiral in 1637 and placed in charge of the fleet. In October 1639 he defeated a Spanish armada in the North Sea off Gravelines, France, in the Battle of the Downs. In the war which broke out between the Dutch Republic and England in 1652 he fought several battles with British fleets commanded by the admirals Robert Blake and George Monk. Tromp was worsted in the Battle of Portland on June 3, 1653, in which the British admiral William Penn also participated. Two more unsuccessful battles with the British in the Channel followed; in the latter engagement Tromp was shot in the heart and died on July 29, 1653. He was buried at Delft, where his marble mausoleum still attracts visitors. S. Van V.

**TROMPE L'OEIL** [trɔ̃′p lœ′y], literally *deceiving the eye,* the art of giving to objects depicted on a flat surface a convincing appearance of three-dimensional reality. It has been practiced ever since Classical times, giving rise to the old stories about fruits so well painted that birds tried to taste them. Seventeenth-century artists especially delighted in these trick representations, rendering books, papers, ribbons, and other objects in such a way as to give a vivid illusion of tangibility. Antonio Gianlisi in Italy, Wallerant Vaillant in the Netherlands, and Marcos Correa in Spain made *trompe l'oeil* paintings, as did also the nineteenth-century American, W. M. Harnett. Pierre Roy is one of the ablest of the twentieth-century exponents. M. Sa.

**TROMSÖ** [tro′msö], a fishing port, tourist center, and capital of Troms *fylke* (county) in northern Norway, 480 mi. northeast of Trondheim. Founded in 1794, Tromsö is on a 6-mi.-long island of that name in the Tromsösund, a fiord sheltered from the Arctic Ocean by the large islands of Kvalöy and Ringvassöy. The surrounding region is wooded to 1,500 ft., with the higher summits covered by ice and snow. Glacially eroded valleys bound high, steep-walled mountains, and the Midnight Sun is visible from May 21 to July 23. Tromsö, the world's most northern bishopric, has a wooden cathedral. It is the point of origin of many Arctic expeditions and contains an important Arctic museum. Smoked, frozen, and dried herring are prepared and exported, and brewing and shipbuilding are engaged in by the inhabitants. Pop. 1952, 11,070. J. E. V.

**TRONDHEIM** [trɔ′nhem], formerly Nidaros, historic city and commercial center and port of central Norway, capital of Sör-Tröndelag *fylke* (county) in central Norway. The city, the third largest in Norway, lies in a broad rolling basin with the Trondheimsfjord at its center. On the southern shore of the fiord, where the city is located, there are large areas of fertile farmland on raised marine terraces interspersed with rounded hills. At the effluence of the Nid River into the Trondheimsfjord, King Olaf I laid out the city of Nidaros ("Mouth of the Nid") in 997. It was expanded and patterned after contemporary English cities by King Olaf II (St. Olaf) in 1016 and was the capital of Norway until 1380. St. Olaf was buried in St. Clement's Church here. On this site was built the Cathedral of Nidaros, the destination of many pilgrimages during the Middle Ages. After the Lutheran Reformation in 1537, the city lost much of its importance, and many of its churches and monasteries were sacked and destroyed. Only in the mid-nineteenth century did the city begin to resume its former importance. Machine works, shipyards, and factories were built. Trondheim acquired new importance when the Constitution of 1814 required that the Norwegian king must be crowned in Nidaros Cathedral. For a time in the 1930's the official name of the city was changed from Trondhjem, which it had been called since the sixteenth century, back to the ancient Nidaros. This change was not popular and was soon given up. During World War II Trondheim was one of the points of invasion of the Germans in April 1940. After initial German landings, an Allied force of Norwegians, French, and British troops attempted to wrest control of the city from the invaders but were forced to withdraw northward to avoid being surrounded by German troops advancing from the south. During this period the city suffered some damage.

Trondheim has a rectangular pattern of wide streets with many stone buildings built as fire protection after the fifteen devastating fires which the city has suffered. The Cathedral, badly damaged during the Reformation and by subsequent fires, has been extensively restored since late in the nineteenth century. The sculptor Gustav Vigeland (1869-1943) did some of his early work on this project. On the Torv, the marketplace, is the Stiftsgaard, the largest wooden building in Norway, which is the king's Trondheim residence. In the southern part of the city is the Technical College of Norway, completed in 1910. The Norwegian Royal Academy of Science, founded in 1760, is located in the cathedral school. Surrounding the city are manufacturing suburbs. The harbor, with shipping and shipbuilding facilities, lies to the north of the low peninsula between the Nid and the fiord on which the city is built. In the east is the old fortress of Kristiansten. To the northeast the port has been enlarged to provide a sheltered, ice-free harbor which has steamship connections with all the Norwegian coast and serves as the beginning of most travel to the northern part of the country. Railways connect Trondheim with Sweden to the east through the low Storlien gap and with Oslo to the south over the high Dovre Railway or the lower Österdalen line. Pop. 1952, 56,377. J. E. V.

**TRONDHEIMSFJORD** [trɔ′nhemsfyɔrd], a broad depression located in central Norway at about 63° 30′ N. lat., the sea-filled part of a wide lowland which almost transects the highland of Scandinavia. To the east the Storlien gap offers a lowland route to the gently rolling plains of Sweden. The fiord, formed on soft Cambro-Silurian rocks and with rolling shores covered with glacial till, extends northeastward from the Atlantic Ocean for about 15 mi. to Agdenes, where it turns southeastward for 15 mi. to the city of Trondheim. There it turns northeastward again for the remaining 55 mi.

of its length. At its mouth south of Agdenes the Trondheimsfjord averages 2 to 3 mi. in width and has its greatest depth, 2,000 ft. In the central part of the fiord near Trondheim the width increases to nearly 16 mi. but the depth decreases to 1,380 ft., which it maintains to its head at Verdalsöra. The only major tributary fiord is the Beitstadfjord on the north, connected with the Trondheimsfjord through the narrow Skarsund, which extends northward about 15 mi. farther.

J. E. V.

**TROPIC BIRD,** any one of three species of medium-sized (32 in.) web-footed sea birds united in the genus *Phaëthon,* which is coextensive with the family Phaëthontidae. They are found in tropical and subtropical seas around the world. They have straight, heavy bills, long wings, and wedge-shaped tails which in adults have the two central feathers enormously elongated. Their plumage is white, marked irregularly with crescentic black bars, and often suffused with a salmon or roseate color. Tropic birds are usually seen far from land, flying at a height of 50 ft. or more above the water and plunging upon their prey of squids and fishes. Their strong flight resembles that of a pigeon. They breed on barren islands, depositing their single egg upon the open ground or in the shelter of a rock, without pretense of a nest. They are commonly known to seamen as boatswain birds, and in Bermuda as longtails. H. G. De.

**TROPISMS** [tro′pɪzəmz], movements of plants or animals in response to their surroundings. Almost any physical agent can cause a reaction in a plant, but the most pronounced responses are caused by light and gravity. Usually the plants bend towards or away from light or from the center of the earth. These curvatures are executed by the growing parts of the plant, and therefore they occur only in the younger parts of stems and roots, and in the leaf and flower stalks of young leaves and flowers. As soon as a stem or leaf stalk is full-grown, it loses the ability to bend and by that time it has reached its permanent position in space. Leaves of leguminous plants form an exception: bean and clover leaves can continue to move with the sun even when they are mature. They have special joints which retain their motility after the leaves are full-grown.

**Geotropism.** Tropisms are divided according to the agent which causes the response. Geotropism is the response of plants to gravity. When roots curve towards the earth, positive geotropism is evident; stem tips which curve away from the earth are negatively geotropic. The curvature of roots is not a mere sagging due to their weight, for in water or even in mercury their tips point downwards. Side roots and side branches are diageotropic growing at a certain angle with the vertical. The typical shape of trees is partly due to this diageotropic response of branches. The branches of the fir stand out horizontally; those of an elm point upwards. These angles are always about the same, regardless of whether the tree grows on a steep slope or not.

The geotropic response is very complex. When the stem tip is cut off, the rest of the stem becomes unable to curve. This led Darwin to suggest that the stem and root tips behave like brain centers, directing the movement of the parts below them.

Much research has been undertaken to discover the mechanism of this response to gravity. It occurs only in the growing parts of plants, and is due to differential growth of the two sides. Therefore the problem is how normal growth is changed under the influence of gravity. A stem grows in length due to small amounts of a growth hormone, auxin, which is formed in the stem-tip. This hormone moves from the tip to the region below; it is in this region that growth in length occurs, and nowhere else in the stem. As long as a negatively geotropic stem is growing upright, the auxin formed in the tip is evenly distributed over all sides of the stem below it, and therefore all sides grow evenly. But when such a stem is placed in a horizontal position, most of the auxin formed flows downward along the lower side, which makes the lower side grow more rapidly and the upper side facing up grows correspondingly more slowly. This difference in growth continues until the tip is pointing upward again, when auxin distribution becomes even, and growth of all sides continues at the same rate. Any deviation of the tip from the vertical causes uneven auxin distribution until the tip has righted itself again.

**Phototropism.** The response to light is called phototropism. Most stems are positively phototropic, as can be seen in plants growing behind a window and bending towards the light. Most leaves are diaphototropic, which means that they place themselves perpendicular to the direction of the light. In this way they are in a position to absorb the maximum amount of light.

Plants differ greatly in their sensitivity to light. In general, seedlings which have to penetrate the dark soil are most sensitive to light. Oat seedlings will curve towards a light which is so dim that eyes must be accustomed to darkness before it can be seen; a very short exposure to light of higher intensity also suffices. When oat seedlings have been grown in a room in complete darkness, a one hundred-watt bulb, from three to five feet away, needs to be turned on for only a second, to make the seedlings bend towards the bulb an hour later.

In many plants the phototropic stimulus is received by the stem-tip only. When the tip is cut off, or when it is kept in darkness while light shines on one side of the rest of the stem, the stem will remain straight. Therefore the place of perception of light is in the stem-tip. The curvature occurs lower down in the most rapidly growing part of the stem, which is about one inch below the stem-tip. This curvature does not start to appear until from one to two hours after illumination. Therefore it is apparent that after perception of the light in the stem-tip the excitation is slowly moving down the stem, and when it has reached the growing cells it causes the reaction. This resembles the reaction of animals to stimuli, where also the perception of the stimulus and the reaction to it occur in different parts of the body. In animals the excitation usually travels much more rapidly along nerves, which are not present in plants.

The transmission of the phototropic stimulus in plants is accomplished by auxin, the same substance which causes the geotropic curvature. When light shines on the stem-tip, from one side, the auxin formed in this tip is shifted towards the dark side. A greater amount of auxin travels downward along the dark side of the stem than on the illuminated side, and when that auxin reaches the growing zone about one hour later, differences in growth appear as a result of differences in the amount of auxin reaching the originally dark and light sides.

**Other Tropisms.** *Traumatotropism.* A curvature due to one-sided wounding of stems or roots is called traumatotropism. Stems usually bend towards the wounded side; roots bend away from it.

*Chemotropism.* A curvature of the plant root toward or away from chemicals in the soil is called chemotropism.

*Hydrotropism.* A curvature due to differences in water content of soils is called hydrotropism. Hydrotropisms, with chemotropisms, are responsible for the development of roots

into parts of the soil with favorable water and mineral content. These are also responsible for the penetration of sewers by tree roots.

*Haptotropism.* Most growing parts of plants are sensitive to touch. This sensitivity may be very great, as in tendrils, which wind around any solid object with which they may come in contact. The tendrils of members of the gourd family are especially sensitive, and on a warm day a few light touches on one side of a tendril will cause a haptotropic curvature within a few minutes.

**Nastic Motions.** Plant movements which are caused by changes in the external environment, but which are always in the same direction regardless of the direction of the stimulus, are nastic movements. The opening and closing of flowers are nastic movements, and best known of all are the sleep movements (nyctynasty) of leaves and flowers. During the night, the leaflets of clover, beans and other leguminous plants fold together, to open again in the morning.

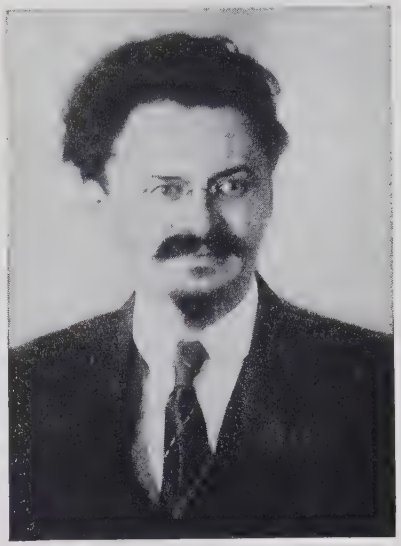
F. W. W.

**TROPOSPHERE.** *See* METEOROLOGY.

**TROPPAU.** *See* OPAVA.

**TROSSACHS, THE** [trɒ'sæks], a mountain defile in the southwest of Perthshire, Scotland, extending from 1 mi. west of Loch Achray to Loch Katrine and flanked by Ben A'an, 1,750 ft., and Ben Venue, 2,393 ft. The gorge is described by Sir Walter Scott in his *Lady of the Lake* and *Rob Roy.* Its name in Gaelic means "bristled country." It is famous for its beauty during the summer and early autumn, when it attracts many sportsmen and tourists. S. Van V.

**TROTSKY, LEON** [trɔ'tskɜɪ; trɒ'tski] (1879-1940), Russian revolutionary, originally Leib Davydovich Bronstein, was born in the village of Yanovka, in the government (now the region) of Kherson, in the Ukraine, on Oct. 26, 1879, and was educated at the University of Odessa. He became a revolutionary and in 1898 was exiled to Siberia, where he met Georgy V. Plekhanov and Nikolai Lenin, both also in exile there because of their revolutionary activities. Trotsky escaped to France and returned to Russia in 1905, when he was exiled for life to Siberia. In less than three months he had escaped to Vienna, where he worked on the staff of the *Arbeiter Zeitung* and *Pravda.* When World War I broke out he went to Switzerland, where he wrote a pamphlet attacking the governments on both sides of the conflict. Consequently the German government, in his absence, condemned him to six months' imprisonment. In 1915 he went to Paris, where he edited the Russian Socialist weekly *Nashe Slovo,* in which he continued to assail the war. He was accordingly expelled to Spain the following year. From Spain Trotsky sailed, by way of Cuba, for New York City. He arrived there in 1917 and for a time was an editor of the Russian Socialist daily *Novy Mir.* Upon the outbreak of the Russian Revolution Trotsky returned to Europe. In Petrograd (now Leningrad) he established a weekly paper, *Vperiod,* and in November 1917 he became People's Commissar for Foreign Affairs. Later, after signing the Treaty of Brest-Litovsk (Mar. 3, 1918), he resigned and became head of the Department of the Army and Navy. After the death of Lenin in 1924 and the subsequent coming to power of Joseph Stalin, Trotsky was expelled from the Russian Communist Party (Bolshevik) on charges of obstructionism, and in January he was banished to Alma-Atka, in Kazakhstan. There he continued to assail the basic policies of Stalin, which had for their primary object the building of socialism within the U.S.S.R.; Trotsky believed instead in fostering revolution elsewhere throughout the world. On being expelled from the country in February 1929 Trotsky made his way to Turkey. In 1933 he went to France, and in 1935 to Norway. In 1937 he settled in Mexico City where, three years later, he was fatally attacked by a man believed to be named Ramon Mercader, who used a pickaxe for a weapon. Trotsky died the next day, Aug. 21, 1940. Among his



*LEON TROTSKY*

CULVER SERVICE

books are *The Defense of Terrorism* (1921), *Literature and Revolution* (1925), *My Life* (1930), and *The History of the Russian Revolution* (1932-1934). R. T.

**TROTWOOD, BETSY,** the dynamic aunt of David in Dickens' novel *David Copperfield,* who rescues David from his stepfather, Edward Murdstone, and provides for his education. DeL. F.

**TROUBADOURS** [tru'bədurz], medieval poets of southern France who composed light but often exquisite lyrics in the Provençal dialect, known as *langue d'oc.* They flourished during the twelfth and thirteenth centuries and used conventional standards established earlier, perhaps by clerks who were familiar with the Latin lyric. An Arab tradition, derived from the Moors who had formerly ruled Septimania, may also have had some influence. The troubadours, often but not always noblemen, sang their songs to their own accompaniment on a guitar or similar instrument. The first known troubadour was William IX, Duke of Aquitaine, eleven of whose lyrics survive. Some are delicate love-songs, others of a libertine nature. Bernart de Ventadour, unlike many of the troubadours, was of humble birth, but became one of the most famous writers of graceful love songs. Among the other troubadours of southern France were Jaufré Rudel, Bertrand de Born, and Peire Vidal. Although most of the songs concerned romantic love and the chivalrous knight, with a setting in beautiful scenes of nature, some had satirical themes. They reflect the more refined civilization of southern France, in contrast to the brutality of northern feudal society, which was depicted in the *chansons de geste.* After 1216 the southern movement declined, due to the Albigensian Crusade, which ruined the brilliant culture of that part of France. But in the twelfth century the fashion had spread to Spain, Sicily, England, and other countries, where kings and great lords bestowed their patronage on the troubadours. After the marriage of

Eleanor of Aquitaine to Louis VII of France, and then to Henry of Anjou, later Henry II of England, the courts of these kings became centers for famous *trouvères,* as the troubadours were called in the north. There they adopted the *langue d'öil* or northern dialect, and their poetry was dominated by *courtoisie,* in which chivalry was subordinated to the glorification of women. Lyric verse generally came to lack spontaneity and tended to grow increasingly stereotyped in a number of conventional forms, such as the *pastourelle,* the *alba* or dawn-song, and the spinning-song. *See also* Provençal Literature. F. C. H.

**TROUT,** important game fishes that are included with salmon in the family Salmonidae. They are distributed circumpolarly in arctic and temperate regions of the Northern Hemisphere. Characterized by soft-rayed fins, small scales, and an adipose fin behind the dorsal fin, trout occur in salt

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*EASTERN BROOK TROUT,* SALVELINUS FONTINALIS

and fresh water and in many cases both sea-run and landlocked populations of the same species are known. All species migrate upstream to spawn. There are two main groups, the chars and trouts, distinguished by the arrangement of the teeth and the shape of the vomer bone in the roof of the mouth. Among the many species of chars, two of the best known are the brook trout, *Salvelinus fontinalis,* of eastern North America and the Dolly Varden, *S. malma,* of the West. These fishes have both red and light spots on a dark body rather than red and black spots on a lighter background found in most *Salmo.* The large lake trout, *Cristivomer namaycush,* of the Great Lakes region and northward, is also a char. The other group of trout includes the steelhead, *S. gairdneri,* or rainbow, a native of the Pacific coastal area, and the brown trout, *S. trutta,* of Europe. Both have been introduced widely in the United States and elsewhere. In the Rocky Mountain region and westward there are other species. Some are of great beauty, such as the golden trout, *S. agua-bonita;* cutthroat trout, *S. clarkii;* and Yellowstone trout, *S. lewisi.* The eggs of trouts can be raised in fish hatcheries and so the fish have been widely distributed. Hybridization makes these fishes difficult to identify. Their beauty and splendid game qualities, as well as their excellent flesh, are praised by all. In many of the southern states the large mouth bass, *Huro salmoides,* and the weakfish, *Cynoscion regalis,* are called trout. Trout have been introduced in the southern hemisphere. The New Zealand and Chilean native trouts belong to a different family, the Galaxiidae. E. C. R.

**TROUT LILY.** *See* Adder's-Tongue.

**TROUVILLE** [tru'vi'l], a seaside resort in the Department of Calvados, northwestern France, 105 mi. northwest of Paris on the coast of Normandy at the mouth of the River Touques, which divides it from the adjoining community of Deauville. As late as 1830 Trouville was only a small fishing village, but thereafter its magnificent sandy beach began to attract visitors, until the promenade bordering it came to be called the "Summer Boulevard of Paris." The chief industry, besides the resort trade, is fishing, especially for oysters. Pop. 1954, 7,040. W. McE.

**TROVATORE, IL** [il tro'vato're], an opera in four acts by Giuseppe Verdi with a libretto by Salvatore Cammarano, derived from the Spanish *El Trovador* by Antonio García Gutiérrez. *Il Trovatore* ("The Troubadour") was first performed on Jan. 19, 1853, in Rome and is one of the most widely known and best loved of all Italian operas. It was written at the height of Verdi's middle period, when he was still chiefly interested in the emotional expressiveness of the voice and had not yet begun the more elaborate use of the orchestra which makes the operas of his old age so surprising and so interesting. The scene of *Il Trovatore* is laid in fifteenth-century Spain, and the plot, like that of *Rigoletto,* is the purest blood-and-thunder melodrama, incorporating the sure-fire elements of mistaken identity, a vengeful gypsy (Azucena, mezzo-soprano), a heroine who poisons herself for love (Leonora, soprano), a handsome young troubadour hero who believes himself the gypsy's son (Manrico, tenor), and a titled villain (the Count di Luna, baritone), who orders the execution of his hated rival Manrico, only to learn, too late, that he has caused the death of his own brother. S. C.

**TROY, SERGEANT.** *See* Sergeant Troy.

**TROY,** known also as Ilios, Ilion, or Ilium, an ancient stronghold in northwestern Asia Minor. Its name has acquired two senses. In the poems of Homer and his successors it means the fortress and city of Priam, which was sacked by Agamemnon and his army in the expedition that recovered Helen. To the historian and archaeologist it means the site of a settlement of the Bronze Age found and first excavated by Heinrich Schliemann in the nineteenth century. Each meaning has distinct associations. The two are inevitably interwoven, but the extent to which they may be equated has long been a matter of disagreement.

The region described by Homer and almost all other ancient writers on Troy is close to the mouth of the Hellespont (Dardanelles) and the coast of the Aegean Sea. In this region, ranges of low hills lie close to the shore, and behind them stretches a flat plain in which flow two small rivers, the Menderes and Dümrek; about three miles inland the ground rises in a steep scarp eighty feet high, beyond which a rolling plateau extends east and south to higher hills and mountains in the distance.

In ancient times the essential historicity of Homer's tale went unquestioned. But Troy was interesting to the ancients poetically, not archaeologically. Modern scholars before 1870, with other aims in view, went far toward dismembering even the poetry of the *Iliad* and *Odyssey,* and all but eliminated any thought of historical truth in the background of the poems.

Heinrich Schliemann, a self-educated German businessman, read Homer with enthusiasm and conceived a passionate belief in the fundamental truth of the stories. In 1870 he began to excavate a mound at the crest of the escarpment near the village of Hissarlik in Asia Minor, a few miles from the mouth of the Dardanelles. Here he found architectural remains in superposed layers, and a wealth of objects of stone, bone, ivory, copper and precious metals, quickly forcing the scholarly world to revise its

conclusions about the Heroic Age. Through accident he failed at first to recognize the layers of the Mycenaean or Late Bronze Age, but deep in the mound he came upon a much earlier citadel, chronologically the second, and confidently named it the city of Priam. After Schliemann's death in 1890 his colleague Wilhelm Dörpfeld continued the work, and Dörpfeld uncovered, in 1893 and 1894, the much more extensive circuit of the Sixth Settlement. This settlement was contemporary with much of the Mycenaean epoch, and was in turn accepted as the Troy of Homeric legend. More recently a minor revision of the dating has been made. Today a few still doubt the validity of archaeological evidence in questions of this kind, but most scholars believe the site at Hissarlik—the only mound of its kind in that region—to be the historical reality that was immortalized by the genius of Homer.

The physical remains themselves were re-examined in detail from 1932 to 1938 by an expedition of the University of Cincinnati under the direction of C. W. Blegen. As a result the strata have been more clearly differentiated, their chronology can now be set forth with greater accuracy, and general conclusions may be drawn.

Troy held a commanding position in the ancient world from a military and economic point of view. From its great fortress and a small outpost on the shore, sea traffic through the Dardanelles could be easily controlled and land routes between Asia and Europe could be supervised. The ruling prince might levy tolls or forbid passage altogether, and the conflicts in this region familiar in later history may well have begun early in the Bronze Age. The site was almost constantly occupied for 3,500 years. In the Bronze Age it was a citadel (in Greek, *πόλις*), not a city. The chieftain lived here with his family and retainers; much of the population lived in small settlements near by, withdrawing to the safety of the fortress only if threatened by enemies. Throughout this period cultural and economic relations were not with the East, but with Western, Aegean civilization, of which the Trojan was in some respects a part.

Most buildings at Troy had walls of crude brick which rested on low stone foundations. When they fell, the ruins were not cleared away but only leveled to make space for new houses. In this way a deep mass of debris grew up. Within it nine major layers can be distinguished, each with many minor strata. Characteristics of the various settlements may be summarized in the following classification:

**Troy I.** The First Settlement, built before 3000 B.C., was a small stronghold, not more than 100 yards in diameter. It had a massive wall of defense with gates and quadrangular towers, preserved even now to a height of 11 feet. Within were rectangular houses, one of which measured 22 by 60 feet. Ten successive phases of this settlement are observable, indicating a long period of occupation. The characteristic pottery is handmade gray or black polished ware. A stone stele with representation of a human figure in low relief provides the earliest example of monumental sculpture in this region. Implements of copper were used from the beginning.

**Troy II.** In the early part of the third millennium B.C. a larger citadel, some 400 feet in diameter, was built above the ruins of the first. This too had thick and lofty walls, projecting towers, and gates. A broad ramp with well-fitted flagstone paving led up from the southwest. The circuit was twice remodeled and expanded, evidently with the increasing power and wealth of the monarchs. A palace or megaron, with deep forecourt and a main hall measuring 33 by 66 feet, is partially preserved near the center of the citadel. Around it are a courtyard and smaller dwellings and storehouses. Seven phases of the Second Settlement are represented by superposed architectural remains. The last was destroyed, after the middle of the third millennium, by a general conflagration so intense that brick and stone were crumbled and calcined in its heat, and so sudden that the inhabitants left stores, household utensils, and valuables in their flight. Several treasures have been found, one of which comprised 3 diadems, 60 earrings, 8,700 beads, 6 bracelets, and 15 vessels of gold and silver. Throughout the settlement thousands of miscellaneous objects and pots of all sorts have come to light. The potter's wheel was introduced in the second phase of Troy II, and red and brown wares came to predominate over the earlier gray and black.

**Troy III-V.** After the destruction of the Second Settlement the site was immediately reoccupied. Settlements III, IV, and V, each larger in extent than its predecessor, carried on the main cultural tradition without interruption. They were composed of groups of small houses separated by narrow lanes. At some stages, perhaps always, there were circuit walls; but these were not so powerfully built as in Troy II, a fact which may indicate a relatively simpler and less aggressive political life. Bones of deer are found in great abundance in the deposit of the Third Settlement, marking either a new influx of this game or the invention of better methods of hunting, or both. The pottery shows a continuation and development of the styles of Troy II. Vessels with plastic representations of human features are common. With the local fabrics are found, as in earlier layers, imported wares characteristic of the Early Bronze Age on the Greek mainland.

**Troy VI.** The first phases of the Sixth Settlement were contemporary with the Middle Bronze Age in Greece (c. 1900-1600 B.C.). They are marked by the introduction of so-called gray Minyan pottery and the first appearance of the horse. After a long period of growth the site entered another phase of extraordinary wealth and power. By 1400 B.C. the citadel was well over two hundred yards in width, having a circuit wall 16 feet thick, composed of hewn stone and constructed in masterly style. At least three towers and four gates stood at intervals about its periphery. Within were concentric rings of substantial houses and palaces, rising on terraces toward the center of the hill (the upper levels of which are no longer in existence; *see below* Troy IX). The buildings of the Sixth Settlement were more pretentious than those of earlier periods; in several, pillars and column bases have been found. A cemetery of the latest phase of Troy VI, where ashes of the dead had been buried in urns, was discovered 550 yards south of the citadel. This era came to an end about 1300 B.C., in a violent earthquake which cracked the walls and shook down the superstructure of the buildings. The inhabitants rescued most of their valuables, however, and left no such array of utensils and ornaments as was found in Troy II. Gray Minyan ware was the predominant local pottery throughout the successive phases of Troy VI; it was supplemented by a few vessels imported from Greece in the Middle Bronze Age and many in the Mycenaean Age, especially in the period from c. 1450 to 1300.

**Troy VII.** After the earthquake the site was again occupied. The great circuit wall was used again, as were parts of standing walls and the many building blocks which lay plentifully at hand. Houses were now smaller, crowded together as if a greater population sought shelter within the fortress. Many large storage jars were set into the floors of the houses, presumably as a provision against shortages

in times of stress. The first phase of the Seventh Settlement, known as VIIa, was destroyed by fire about 1200 B.C., quite possibly after a long siege and final sack by an enemy. The coincidence of date and other evidence makes it seem probable that this was the actual destruction which came to be reflected in poetic legend. After the fall of Troy VIIa, some of the population returned and settled again on the hill, at first alone, later joined or temporarily subjugated by an alien people. The latter brought with them a rude handmade pottery, which is a characteristic mark of Phase VIIb and is believed to show European connections.

**Troy VIII.** The term Eighth Settlement covers the long period between the Early Iron Age and the establishment of the Hellenistic monarchs in Asia Minor. Troy now became a Greek town. Well settled in the first phases, it appears to have declined in the sixth century B.C., and part of the population may have abandoned the site. In any case it had little political importance. In a sanctuary on the southwest slope of the acropolis, sacrifices were performed, perhaps to Cybele; and there may also have been a temple to Athena at the summit. Corinthian and East Greek pottery has been found in large quantities, along with local wares of types descended in unbroken sequence from the Middle Bronze Age.

**Troy IX.** In the Hellenistic Age the site, known as Ilion, was unimportant except by its connection with the heroic past. Alexander the Great paid his respects here in 334 B.C., and the town was honored by his successors. They and the Julian emperors of Rome undertook extensive programs of rebuilding: the top of the hill was cut away and leveled (an operation which eliminated layers of the Eighth, Seventh, and Sixth Settlements, to the confusion of Schliemann and the regret of archaeologists in general); a temple and precinct of Athena were built there; public buildings were erected on the mound and on the plateau to the south, which was also surrounded by a wall; and a large theatre was built in the scarp to the northeast. Ilion was a thriving community to the time of Constantine the Great, who considered but rejected it as the site of his eastern capital. With the growth of Constantinople the town declined to insignificance.

J. L. C.

**TROY,** a city in southeastern Alabama, the county seat of Pike Co., situated about 45 mi. southeast of Montgomery, in a timber and farming area. It was founded in 1839 and incorporated in 1843 as a city. Troy is administered by a city commission. It is the home of a state teachers college. The city is served by the Atlantic Coast Line and the Central of Georgia railroads. Manufactures include fertilizers, crates, boxes, and other lumber products. The agricultural products of the area are cotton, corn, peanuts, and livestock. Pop. 1950, 8,555.

**TROY,** a city in eastern New York, the county seat of Rensselaer Co., situated on the east bank of the Hudson River, at the head of tidewater navigation and opposite the mouth of the Mohawk River, 6 mi. northeast of Albany. The State Barge Canal at Waterford nearby connects Troy with Canada. The Erie Canal, also at Waterford, gives the city a water route to Canada and to the states of the Midwest and Northwest. Troy is a manufacturing community and the center of the shirt and collar industry, producing about 80 per cent of the output of the entire country. The site of the city was settled by the Dutch under the Van Rensselaer Manor Grant of 1629. The townsite was surveyed in 1786, and Troy was incorporated as a village in 1798, the city charter being granted in 1816. Hannah Lord Montague invented a detachable collar for men's shirts in 1825, and Ebenezer Brown began their manufacture in 1829. Horatio Winslow purchased the right to manufacture and sell Bessemer steel and began production in his foundry in 1864, but Troy's activity as a steel center lasted only until 1873 when Andrew Carnegie built a steel mill near Pittsburgh, Pa. Samuel Wilson, a Troy brickmaker, opened a slaughterhouse at the turn of the nineteenth century. The city is the seat of Rensselaer Polytechnic Institute, established in 1824, the oldest engineering college in the nation; Russell Sage College; the Emma Willard School; and the La Salle Institute. Watervliet Arsenal is 1 mi. distant on the west bank of the Hudson.

Troy is served by the Boston and Maine, the Delaware and Hudson, the New York Central, and the Troy Union railroads and by river craft. Besides shirts and collars, manufactures include knit goods, men's clothing, iron and steel machinery, valves, stoves, auto parts, engineering instruments, coke, and brushes. Pop. 1950, 72,311.

D. D. M.

**TROY,** a city in western Ohio, the county seat of Miami Co., situated on the Great Miami River, 20 mi. northwest of Dayton. The New York Central and the Baltimore & Ohio railroads serve the community. Troy is the trading center of an area in which grain, fruit, and cattle are important. Manufactures include furniture, office equipment, gummed paper, airplanes, and welded products. Troy was first incorporated in 1814. The local government is administered by a mayor and council. Pop. 1950, 10,661.

**TROYES** [trwɑ′], capital of the department of Aube in northeastern France. It lies on the River Seine, which here divides into several arms, 85 mi. southeast of Paris. In Roman times the capital of a Celtic tribe called the Tricassi, Troyes escaped attack by Attila's Huns in the fifth century through the efforts of one of its first bishops, St. Loup, but was pillaged by the Northmen in 890 and 905. Becoming the capital of the Counts of Champagne in 1019, it grew to be an important trading center. Here in 1420, after Troyes had fallen into the hands of the Burgundians and the English, the Treaty of Troyes was signed, acknowledging Henry V of England as Regent of France, but in 1429 the city was freed by Joan of Arc. During the sixteenth century Troyes developed an important school of painters and sculptors.

The best-known products of Troyes are glassware, textiles and hosiery, and pork. It also manufactures casks, locks, knitted wear, and copper utensils and markets wheat, dried legumes, and wines. Pop. 1954, 58,819.

W. McE.

**TROYES, TREATY OF,** an agreement between Charles VI of France and Henry V of England signed at Troyes, France, May 21, 1420, during the Hundred Years' War. It was negotiated by Duke Philip of Burgundy following the assassination of his father, Duke John the Fearless, by a member of the Armagnac faction while John was attempting to bring peace between the two parties in face of the English conquest of Normandy. According to the terms of the treaty, Henry V of England was designated regent for, and successor to, Charles VI, who was mentally ill, the Dauphin being repudiated as the lawful heir. Henry was given the hand of Catherine, the French king's daughter, and control of northern France. Two years later both kings were dead, and the infant son of Henry and Catherine, Henry VI, was proclaimed king of England and France.

F. C. H.

**TROYON, CONSTANT** [trwa′yõ′] (1810-1865), French painter, was born on Aug. 28, 1810, in Sèvres near

Paris. Largely self-taught, he joined the landscapists of Barbizon in 1848. Here he found the subjects which were to remain characteristic of his work: landscapes with cows and sheep. Troyon's numerous paintings, once very highly rated, are in many European museums and in Boston, Brooklyn, Chicago, Cincinnati, Minneapolis, Montreal, New York, Philadelphia, Toledo, and in the Corcoran Gallery, Washington. He died on March 20, 1865. K. B.

**TRUBETSKOY, PRINCE NIKOLAI SERGEYEVICH** [trubyətskoi′] (1890-1938), Russian linguist, was born Apr. 16, 1890, in Moscow. The son of Prince Sergei Trubetskoy (1862-1905), professor of philosophy and rector of the University of Moscow, Nikolai Trubetskoy inherited a strong philosophical mentality, which he applied with far-reaching results to his linguistic investigations. Driven into exile by the Russian revolution, he joined with V. Mathesius and R. Jakobson in forming the "Prague school," which was to initiate one of the most fruitful trends of contemporary linguistics, the so-called structural study of language. His works *Zur allgemeinen Theorie der phonologischen Vokalsysteme* (in *Travaux du cercle linguistique de Prague,* vol. 1, 1929), *Anleitung zu phonologischen Beschreibungen* (1935) (*Travaux,* vol. 5), *Gedanken zum Indogermanenproblem* (*Acta linguistica,* vol. 1), *Grundzüge der Phonologie* (*Travaux,* vol. 7), and *Alphabet und Lautsystem* (*Slovo a stovesnost,* vol. 1) are of transcendent importance in modern linguistics. He was also a specialist in Slavic, Finno-Ugric and Caucasian languages, and knew thoroughly the literature, ethnography, folklore, and history of these peoples. His linguistic approach was at the same time historical and philosophical and gave his work a broad human outlook. Trubetskoy died in Vienna, June 25, 1938. G. B.

**TRUCE OF GOD,** the temporary cessation of all private warfare in feudal times on days determined by the Church. The penalty of disobedience was excommunication. It was first introduced by the Church in France in the eleventh century in an effort to limit unending and uncontrollable private feuds. The Truce of God first lasted from Saturday night to Monday morning, but gradually embraced feast days, and even the whole of Lent and Advent, until three-quarters of the year was included. The growing power of secular authorities finally enabled them to eradicate private warfare, and rendered obsolete the ecclesiastical Truce of God. F. A. F.

**TRUCIAL OMAN** [tru′shəl oma′n], also known as the Trucial States, a region extending 400 mi. along the southern coast of the Persian Gulf, bounded on the northwest by Qatar; on the west and south by al-Hasa and Nejd, Saudi Arabia; on the southeast by Oman; on the east by the Gulf of Oman; and on the northeast by Oman. It is composed of seven sheikdoms under British protection, including Abu Dhabi, Ajman, Dibai, Kalba, Ras al Khaimah, Sharja, and Umm al Qawain, and has a population of about 80,000 in an area of 6,000 sq. mi. Abu Dhabi and Dibai, both on the Persian Gulf, are the principal ports. The capital is Sharja (5,000), in the eastern end of the country, on the Persian Gulf.

Like Oman proper and al-Hasa, Trucial Oman consists of a wide interior desert plateau and narrow coastal plain. The rain is scant and the temperature high, but springs permit cultivation in the oases. Dates and sorghums are grown, and pearling is a rather profitable business along the coast. Most of the pearls are shipped to India. The former name, "Pirate Coast," indicates an earlier occupation of the sheiks.

In the nineteenth century, beginning with 1820, the various sheiks recognized Britain's authority, agreed to abolish piracy and slavery in the area, and promised not to cede territory to anyone and not to negotiate treaties with anyone except Britain. The British agent for the area resides at Sharja and is under the direction of the Persian Gulf Residency. H. C. K.

**TRUDEAU, EDWARD LIVINGSTON** [tru′do] (1848-1915), American physician and pioneer in the treatment of tuberculosis, was born in New York City, Oct. 5, 1848. In 1865, he entered a preparatory school at Newport, R. I., to study for appointment as midshipman in the navy. However, he left to nurse his brother, who shortly afterward died of tuberculosis. In 1868, Trudeau took up the study of medicine at the College of Physicians and Surgeons and qualified as house physician at Strangers' Hospital two months before he received his M.D. in 1871. In 1872 he became associated with Dr. Fessenden N. Otis. Trudeau's health failed the following year, the diagnosis being extensive pulmonary tuberculosis. After a brief stay at Aiken, S. C., he went to the Adirondacks, then spent the winter in Minneapolis, returning to the Adirondacks much worse. Basing his method on his self-treatment, Trudeau pioneered in the open-air treatment of tuberculosis, soon becoming recognized as the foremost authority on the disease and its treatment. The work of Herman Brehmer and Peter Dettweiler suggested the idea which led to Trudeau's founding of the Adirondacks Cottage Sanatorium in 1885, now Trudeau Sanatorium, which at his death had thirty-six buildings. In 1894 he founded the Saranac Laboratory, the first of its kind, for the study of tuberculosis. Trudeau had worked with tuberculin before Robert Koch published his discovery of it. He helped found St. John's-in-the-Wilderness and St. Luke's Church, Saranac Lake. He was a member of the American Climatological Association and Association of American Physicians (president, 1905) and president of the Congress of American Physicians and Surgeons, Washington, 1910. He was a founder and first president of the National Association for Study and Prevention of Tuberculosis, 1905. His honorary degrees were M.S., Columbia University (1899) and LL.D., McGill University (1904) and University of Pennsylvania (1913). He wrote several papers on tuberculosis for medical journals. He died at Saranac Lake, Nov. 15, 1915. His *Autobiography* was published one year later, in 1916. D. D. M.

**TRUE STORY, A,** by Lucian of Samosata (c. A.D. 120-180), a parody of the marvelous travelers' tales of his predecessors in Greek literature—poets, historians, and philosophers. Lucian gives his readers fair warning that only one of his statements is true, namely that what he will tell them is all lies. He describes how his ship, sailing westward through the Pillars of Heracles (Strait of Gibraltar), was caught up on the second day and carried along for seventy-nine days by a violent gale, and finally deposited by a whirlwind on the moon. Lucian fought valiantly in a war between the Moonites and the Sunites, but was taken prisoner. Returning to the Ocean, he and his ship were swallowed up by a whale; he escaped by lighting fires inside the whale, and then traveled to the Isles of the Blest and the Isle of Dreams. The book ends, after a visit to Calypso and the Donkey-legged Sirens, with what has been called the biggest lie of all—a promise to continue the story in other books. This entertaining satire has been the inspiration of many subsequent works, among them *Gulliver's Travels* and the tall tales of Baron Münchhausen. *See also* LUCIAN. C. M. D.

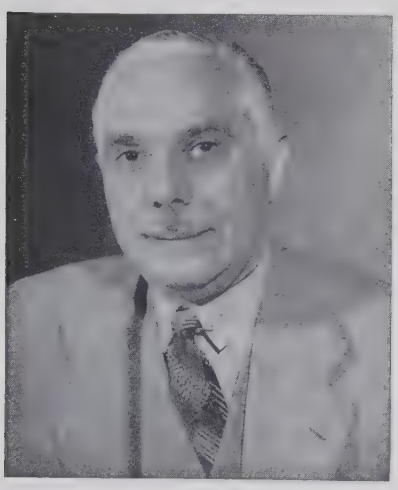
**TRUFFLE** [tru′fəl; trʌ′fəl], a genus, *Tuber,* of globose sac fungi usually found growing under deciduous trees, a foot or more below the surface of the ground. This genus includes many species native chiefly to Europe; some of them are edible, and these resemble mushrooms in their agreeable flavor. They vary from the size of an acorn to the size of a potato.

M. G. W.

**TRUJILLO** [truhi′yo], the principal city on the northern coast of Peru and capital of the department of La Libertad. It is an important commercial center and the outlet of a rich sugar-producing region. The exact date of the city's founding is unknown, but it was named in 1535 by Francisco Pizarro. Its streets and main plaza are reminiscent of a Spanish city, and many of the colonial mansions of the nobility still stand. Tourists and archaeologists are attracted by ruins of the pre-Incan Chimu civilization, whose capital, Chan-Chan, is 2 mi. from Trujillo. Traces of the old city walls, built as a defense against English pirates, remain. Salaverry, 7 mi. south, is the port for Trujillo. Pop. (est. 1947), 45,014.

S. G. I.

**TRUJILLO MOLINA, RAFAEL LEÓNIDAS** [truhi′yo moli′nɑ] (1891- ), Dominican generalissimo and dictator, was born in San Cristóbal, Oct. 24, 1891. After elementary schooling he worked in a telegraph office, then entered upon an army career. In 1927 he became a general and was given command of the national police. A revolt



*RAFAEL TRUJILLO MOLINA*

COURTESY OF THE DOMINICAN INFORMATION CENTER

forced President Horacio Vasquez from office in 1929, and Trujillo was elected president on May 16, 1930. He has since dominated the affairs of the Dominican Republic. He assumed the title of generalissimo in 1932 and remained president except for the interval 1938-1942 until his retirement in 1952, when his brother Hector Trujillo was elected to the presidency. Although Trujillo's authoritarian and sometimes violent methods aroused strong criticism at home and abroad, he is credited with much of his country's material progress. The Dominican capital, Santo Domingo, was renamed Ciudad Trujillo in his honor in 1936 after he had rebuilt and modernized it following the 1930 hurricane devastation.

S. G. I.

**TRUK** [tru′k], a cluster of twelve high, volcanic islands and many lesser islets, lying in a large lagoon girdled by a coral reef, in the Caroline Islands in the western Pacific Ocean (8° N. lat.; 152° E. long.). Its area is about 50 sq. mi. Before World War II Truk was reported to have a population of about 16,000. Mandated to Japan in 1920 by the League of Nations, it was subsequently transformed into a powerful air and naval base in defiance of the terms of the mandate. As such it served as one of the main springboards for Japanese advances south and east in the early months of World War II. Although shore installations and shipping in the harbor were heavily damaged or destroyed by American air attacks toward the end of the war, it was not occupied by United States forces until after the Japanese surrender in September 1945, the island having already been by-passed by American landings in the Marianas to the north. R. G. B.

**TRUMAN, HARRY S.** (1884- ), thirty-second President of the United States, was born on a farm near Lamar, Mo., on May 8, 1884, and grew up on a farm near Independence, Jackson Co., Mo. His middle initial, S, does not stand for anything, but was allegedly chosen because his parents could not decide whether to name him for his grandfather Shippe or for his grandfather Solomon. After going through high school in Independence, he sought appointment to West Point but was rejected because of a weak eye. Lacking funds for a college education, he went to Kansas City, Mo., where he worked at various jobs, enlisted in the Missouri National Guard, and became a bank clerk. From 1906 to 1917 he managed his father's 600-acre farm at Grandview, Mo. After his National Guard regiment was mobilized in 1917, he entered the Field Artillery School at Fort Sill, Okla., sailing for France in 1917 as a lieutenant. Truman was soon promoted to captain in Battery D, 129 Field Artillery Battalion, 35th Division, A.E.F., and returned to the United States a major in 1919, having participated in combat operations at St. Mihiel and in the Argonne offensive. He married Elizabeth Virginia Wallace on June 28, 1919, soon after his return. With an army associate he invested his savings in a Kansas City haberdashery, but this venture was a failure.

Discouraged by his lack of business success and without funds, he sought the help of friends. His farm background, his war record, his Masonic connections, his Baptist Church affiliations, and his genial personality recommended him to Thomas J. Pendergast, the political boss of Kansas City and much of western Missouri, and Truman was appointed Overseer of Highways for Jackson Co. In 1922 he was elected a county judge for Jackson Co., notwithstanding the fact that he was not a lawyer. To make up for this deficiency, Truman studied nights for two years at Kansas City Law School. In 1924 he was defeated for re-election, but in 1926 he was returned to office as presiding judge of the court, the duties of which also involved administrative supervision of many county expenditures, including $60,000,000 for public works. In 1934 he was elected United States Senator on the Democratic ticket. His first term in office was notable chiefly for his unsuccessful fight to prevent the renomination of Maurice Milligan for United States District Attorney for the Western District of Missouri; Milligan had obtained the conviction of thirty-five Pendergast "ward leaders" for vote frauds. During his second term Truman achieved wider recognition as the energetic and forthright chairman of the Senate committee investigating war contracts. Clashing at times with the policies of the Roosevelt administration, he effected considerable savings in government contracts, urged efficiency in war production and administration, and forced changes in the aircraft and ship construction programs.

In 1944, after Vice-President Henry A. Wallace had been rejected by the Democratic convention as a candidate for re-election, Truman supported James F. Byrnes of South Carolina for that office. Truman himself was nominated as

a compromise candidate, however, and he was elected. Upon the death of President Roosevelt on Apr. 12, 1945, Truman became the thirty-second President of the United States, pledging himself to carry out the domestic and foreign policies of his predecessor.

On April 25 his telephoned speech opened the San Francisco Conference establishing the United Nations Organization. A week later Germany surrendered, and from July 17 to August 2 Truman attended the Potsdam Conference with Winston Churchill and, later, Clement Attlee of Great Britain and Joseph Stalin of the Soviet Union. Then, having approved the atomic bomb targets selected by the Atomic Energy Committee, headed by Secretary of War Henry L. Stimson, he authorized the bombing of Hiroshima, Japan, Aug. 6, 1945, and Nagasaki three days later. After the Japanese surrender, Truman yielded to popular pressure and began the dismantling of the United States war machine.

In the months following World War II, Truman sought to retain price controls but yielded somewhat in the face of bitter popular opposition. He was also obliged to face postwar strikes, particularly those of the miners and the railroad workers, and for a time he was at odds with organized labor, though he regained its support by his later attempts to have the Taft-Hartley Labor Relations law repealed. Although he furthered bipartisan co-operation in foreign policy, his opposition to tax cuts, his insistence on price controls, and his alleged lack of aggressive support of labor programs resulted in a Republican majority in both houses of Congress after the elections of 1946. Gradually Truman created his own administration, which sponsored the "Fair Deal" as a label expressive of its goal in domestic affairs. One of the many cabinet changes of this period was the dismissal in 1946 of Henry A. Wallace, who had been made Secretary of Commerce in Roosevelt's fourth cabinet, because of his outspoken criticism of the administration's foreign policy. This policy was made concrete in the Truman Doctrine of containing Communist expansion by furnishing American aid to Europe and Asia, and particularly to Greece and Turkey. A corollary of this doctrine was the Marshall Plan, which was enacted into law as the European Recovery Program (E.R.P.) and led ultimately to the North Atlantic Alliance.

In 1947 Truman asked Congress for stand-by price controls, rationing, and bank and consumer credit control as parts of an anti-inflation program, but he was ignored. In September he attended the Inter-American Defense Conference in Brazil. To increase the efficiency of the executive branch of the government, he appointed a commission headed by former President Hoover which, after thorough study, recommended numerous changes, including unification of the armed services. In his State of the Union Message of Jan. 7, 1948, Truman called for rent control, social security, universal military training, national health insurance, and other social legislation. The next week he again asked for passage of his anti-inflation measures. On February 2 he asked for civil-rights legislation, including a Federal antilynching law, a Federal fair employment practices commission, a permanent civil-rights commission, and abolition of the poll tax—measures that enraged many Southern Democrats. Later in the year, he asked for a resumption of selective service and for an increase of $500,000,000 in the Export-Import Bank funds available to South America. On May 14, President Truman announced recognition of the new state of Israel, making the United States the first major power to do so.

As the presidential election of 1948 approached, Truman was given little chance for re-election, for his policies had alienated many of his own party. He was finally nominated by the Democratic Party, with Senator Alben W. Barkley of Kentucky as the vice-presidential candidate, but this action produced what seemed to be a fatal split in the party ranks. Henry Wallace, the candidate of the Progressive Party, was expected to divert many Democratic votes, and an even more serious threat was the defection of a large bloc of Southern

FABIAN BACHRACH

*HARRY S. TRUMAN, THIRTY-SECOND PRESIDENT OF THE UNITED STATES*

Democrats, popularly known as "Dixiecrats," offended by the strong civil-rights planks in the party platform. During his energetic campaign, Truman blasted the 80th Congress for its lack of action and held out promises of Federal support for housing, health, and social security. Other promises were for higher unemployment insurance payments, a national medical program, crop insurance, the continued subsidy of farm prices, and the end of segregation, especially in educational institutions. Before Congress adjourned, he had signed bills putting into operation the first peace-time draft and augmenting foreign aid. Truman's attractive programs, a switch of votes in the farm states, and the vigorous support of organized labor secured his unexpected re-election against weak, self-assured Republican opposition, and despite the split in the Democratic ranks.

During Truman's second term as president, he continued to press for civil-rights legislation, compulsory national health insurance, and other domestic measures associated with his Fair Deal program. In foreign affairs, he developed his Point Four program of aid to underdeveloped countries as one means of containing Communist expansionism. The increasing resistance to Communism was also evidenced by the creation, in 1949, of the North Atlantic Treaty Organization to superintend the integration of the military forces of its member nations in Western Europe. A further step was taken in 1951, with the establishment of

the Mutual Security Agency to co-ordinate American economic, technical, and military aid abroad.

In the meantime, the Communist invasion of South Korea in June 1950 and the consequent involvement of substantial American forces in the United Nations army of resistance produced a marked acceleration in American defense measures. Rearmament in the United States was enormously expanded, and the integration of European defense was given new impetus when N.A.T.O. accepted the President's nomination of Gen. Dwight D. Eisenhower as Supreme Commander of the North Atlantic Unified Defense Forces.

The President's dismissal of Gen. Douglas MacArthur in 1951 touched off a violent debate on American Far Eastern policy, and, on the political front, the discovery of scandals in the Reconstruction Finance Corporation and especially in the Bureau of Internal Revenue opened the Administration to sharp attack. After announcing in March 1952 that he would not be a candidate for re-election, Truman indicated his choice for the Democratic candidate to be Gov. Adlai Stevenson of Illinois. Truman actively campaigned for the election of Governor Stevenson, but a vigorous Republican campaign won the election for Dwight D. Eisenhower. Truman left Washington on Jan. 20, 1953, and settled in his home in Independence, Mo. There he devoted himself to the projected Harry S. Truman Library at Grandview, Mo., and to work on his memoirs; the first volume, *Year of Decisions,* was published in November 1955.

T. R. H.

**TRUMBULL, JOHN** (1750-1831), American poet and leader among the "Hartford Wits," was born at Westbury (now Watertown), Conn., April 24, 1750. His valedictory oration at Yale, entitled *An Essay on the Uses and Advantages of the Fine Arts* (1770), called for establishment of an American literature not dependent on models from abroad. His lively versified burlesque, *The Progress of Dulness* (1772-1773), which satirized contemporary men and collegiate manners, and two equally caustic series of essays, *The Meddler* (1769-1770) and *The Correspondent* (1770-1773), brought him into partisan controversy. Removing to Boston in 1773, he studied law with John Adams and was probably author of the popular and patriotic bombastic poem *An Elegy on the Times* (1774). He was already withdrawing by this time from the turbulence of literary give-and-take, so that although the first part of his mock-epic *M'Fingal* appeared in 1775, the work was not completed until 1782. Trumbull undoubtedly had some hand in *The Anarchiad* (1786-1787) and *The Echo* (1791-1805), occasional satirical attacks against democratic liberalism, but in general he withdrew almost entirely from public literary activities after the Revolution to devote himself to legal and political matters. He died at Detroit, Mich., May 12, 1831.

L. L.

**TRUMBULL, JOHN** [trʌ′mbəl] (1756-1843), American historical and portrait painter, was born at Lebanon, Conn., June 6, 1756. A graduate of Harvard College, he served in the Continental Army and later studied under Benjamin West in London. Trumbull's greatest achievement was a series of ambitious and detailed paintings of the outstanding events and personalities of the Revolution. Four of the series were commissioned by Congress for the rotunda of the Capitol. He was a founder and the first president of the American Academy of Fine Arts in New York City. He died in New York on Nov. 10, 1843. E. B. S.

**TRUMBULL, JONATHAN** (1710-1785), American Revolutionary statesman, was born Oct. 12, 1710, at Lebanon, Conn. He graduated from Harvard College in 1727, and was preparing to enter the ministry when family difficulties obliged him to enter his father's mercantile business. He then studied law, and in 1733 was sent to the General Assembly; in 1740 he was chosen assistant to the governor, serving until 1750. In 1766 he was made both deputy governor of Connecticut and chief justice of the Connecticut Supreme Court, and in October 1769 he was elected by the Assembly to the governorship, a position he held until 1784. When the Revolutionary War began, Trumbull was the only colonial governor to side with the colonies. He was a frequent correspondent with General George Washington and helped supply materials to the Continental Army. One of his sons, Jonathan, Jr. (1740-1809), also became governor of Connecticut, and another, John (1756-1843), became famous as a painter. Trumbull died Aug. 17, 1785, at Lebanon.

W. E. A.

**TRUMPET,** a general name for lip-blown musical instruments which have long, narrow, and relatively straight tubes, in contrast to the more curving conical tubes associated with the horn. Trumpets originated in the hollow branches and shells used by primitive peoples at an early stage to give their voices an unnatural, awe-inspiring quality, and later to sound fierce blasts carrying a magical significance. Not until man learned the use of metal, however, could he produce typical trumpets with long, straight, narrow tubes and piercing tones. Such trumpets were known to ancient civilizations from China to Rome; often pairs of extremely long instruments were employed, alternating in the production of two or three tones. In addition to serving in religious rites, these trumpets often figured as military instruments, and in Asia they came to be associated, like the large kettledrums, with persons of rank and nobility.

In Europe, use of the trumpet declined with the disintegration of Roman civilization, but eventually it was inspired anew through European contacts with the Islamic world during the Crusades. With the instrument itself came its military and aristocratic associations, with the result that it was several centuries before the trumpet became important in concert music as well as in military music. By about 1500 the tube had been lengthened and folded into its present oblong shape for convenience, and the all-powerful trumpeters' guilds had come to be made up of two very different types of players: field trumpeters who performed military calls and flourishes "by ear" in the lower and middle registers; and chamber trumpeters, skilled musicians who read and played complex parts in the difficult upper register. This brilliant style of melodic trumpet playing, achieved on natural trumpets by means of the lips alone, reached its peak at the time of J. S. Bach (1685-1750). With the rise of homophonic music in the latter half of the eighteenth century, the trumpet remained in the orchestra chiefly as a rhythmic and color instrument, like the kettledrum.

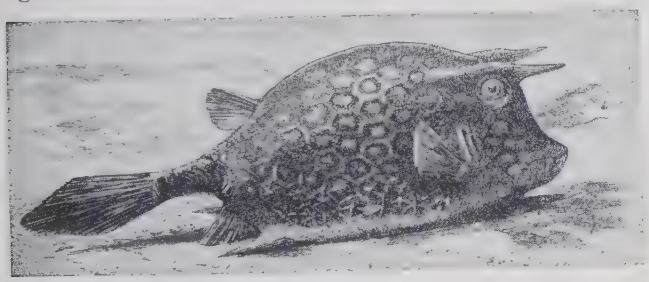
The nineteenth century, however, saw the renascence of the trumpet, made possible by the introduction of a valve or piston mechanism for obtaining all tones of the chromatic scale. Military bands were the first (c. 1820-1840) to utilize the many varieties and pitches produced by experimenting designers, but by 1850 or 1860 a pair of trumpets was found in most symphony and opera orchestras. Richard Wagner and his followers used alto, tenor, bass, and even contrabass trumpets, but today only the soprano, in B-flat or A, is common. Its brilliantly penetrating tone, less soft and blending than that of the "Bach trumpet," less mellow and flexible than that of the modern cornet, is at home in band, orchestra, and especially in American popular music. W. Li.

**TRUMPET TREE,** a large-leaved tree, *Cecropia peltata,* of the mulberry family, native to tropical America. It has hollow stems and branches, used for making wind instruments, and a milky juice somewhat like rubber. The strong fibrous bark is made into cordage, and the Indians made fire by friction of this bark against harder woods. A peculiar feature of this tree is colonies of ants that live inside the hollow stems and, in return for shelter and food, protect the tree from attacks of leaf-cutter ants. J. C. Wis.

**TRUMPET VINE,** a deciduous woody climber, *Campsis radicans,* of the bignonia family, also known as the trumpet creeper. Native to woods from New Jersey to Iowa, and south to Florida and Texas, the trumpet vine is the state flower of Kentucky. It is cultivated for its handsome orange to scarlet flowers, which are trumpet-shaped, about 3 in. long, and borne in a large terminal cluster in midsummer. The vines may climb to a height of 40 ft., clinging by means of aerial rootlets; the leaves are opposite and pinnately divided, and the long fruit pods contain numerous flat seeds with transparent wings. The Chinese trumpet vine, *C. grandiflora,* is an even showier plant, and when hybridized with *C. radicans* forms a fine hardy variety. J. C. Wis.

**TRUNKBACK.** *See* LEATHERBACK.

**TRUNKFISH,** small marine fishes of the family Ostraciidae that are encased in a bony box. The triangular-shaped body shell consists of six-sided plates which are fused together leaving openings only for the mouth, eyes, and fins.



TRUNKFISH

FROM WOOD'S *NATURAL HISTORY*

Some species have long horns over the eye and are called cowfish. About 20 species are found in shallow water of tropical seas. Four species of the genus *Lactophrys* are regularly found in Florida and the young are sometimes carried northward as far as Massachusetts by the Gulf Stream. They reach a length of 9 to 16 in. They swim slowly by a sculling motion of the dorsal and anal fins, and by the control of water jets from their gill slits. The tail fin usually acts as a rudder. They are good food fish, usually baked whole in the shell. E. C. R.

**TRUNNION, COMMODORE** [trʌ′nyən], Peregrine's generous, plainspoken guardian in Tobias Smollett's novel *The Adventures of Peregrine Pickle.* Until he marries Peregrine's Aunt Grizzle, he maintains shipboard customs on a country estate. R. M. W.

**TRURO** [tru′ro], the county town of Colchester Co., Nova Scotia, Canada, 62 mi. north of Halifax, situated on the Salmon River near its entrance into Cobequid Bay. It is the hub of land transportation in Nova Scotia. Radiating from it are the lines of the Canadian National and Dominion Atlantic railways and Provincial Highways 2, 4, and 11. The site of an Acadian settlement known as Cobequid, destroyed in 1755, Truro was resettled by fifty-three New Hampshire families in 1761. The town was incorporated in 1876. Near by are large areas of diked tidal lands. Dairying is important in the surrounding agricultural district. Local industries produce woolen underwear, hosiery, cloth, hats, shirts, lumber, builders' supplies, and dairy products. The first milk-condensing plant in Canada, established in 1885, was still in operation in 1952. In Truro are located the Nova Scotia Agricultural College and the Provincial Normal College. In the vicinity is Victoria Park. Pop. 1951, 10,756. D. F. P.

**TRUST,** in law, a fiduciary relationship created either expressly or by operation of law, in which one or more persons, called trustees, hold legal title and control of property or a property interest subject to an obligation to deal with the trust properly for the benefit of another or others, called the beneficiaries or *cestuis que trustent.*

**The Use.** Trusts are said to have been introduced into England following the Norman Conquest, and a form of trust known as a "use" became a common form of ownership of land. The use was a device which, under highly formalized early English law, served the purpose of enabling the beneficiary of the use to escape various responsibilities and burdens attached to the ownership of legal title to land. The Statute of Mortmain, in 1217, prohibited the conveyance of land to religious orders. This disability was circumvented by conveyance to a religious-minded individual, who permitted the ecclesiastical body to use the property as its own.

The Statute of Uses, enacted by Parliament in 1534, enumerated in its preamble the abuses and evasions of law which the use engendered, and ordained that legal title to land should be deemed vested in the beneficiary of the use. The Statute of Uses was interpreted by the courts not to be applicable to conveyances to trustees, upon whom were imposed active duties of management, or to trusts of personality.

**Express Trusts.** In modern times, express trusts in real property, securities, or funds, are commonly created by will and are known as testamentary trusts. Express trusts may also be created during the lifetime of the owner of property by its conveyance to trustees for the benefit of the intended *cestui que trust.*

A typical express trust requires the trustees thereof to receive the income of the corpus of the trust and to apply the net yield to the named beneficiaries until the termination of the trust period and provides for the distribution of the principal upon such termination.

In the absence of statutory provision establishing other requirements, it is generally held that an indestructible trust must be limited to a period of lives in being and twenty-one years, at the expiration of which time the trust property must be distributed. In New York State, absolute ownership and right to possession of those entitled to share in the distribution of trust property at its termination, its "remaindermen," must rest within a period which shall not be longer than the duration of the lives of two specified persons living at the time of the death of the testator, in the case of testamentary trusts, or at the date of conveyance to trustees where the trust is created by deed.

However, charitable trusts, as distinguished from private trusts, are generally not subject to limitation of this nature.

**Constructive Trust.** "Constructive trust" is the designation given to a trust imposed by operation of law on the ground of public policy, so as to prevent unjust enrichment and betrayal by a person in whom special confidence is placed in consequence of relationship or status. For example,

although an oral promise to reconvey real estate upon demand is enforcible under the Statute of Frauds, which requires that such agreement be in writing, nevertheless, if the promise of reconveyance be made by one spouse to the other, or by a son or daughter to a parent, the relationship of trust and confidence implicit in the situation will induce a court of equity to enforce the promise of reconveyance as a constructive trust.

**Resulting Trust.** When a person purchases real estate with his own funds, but directs the seller to execute the deed to a third person, courts of equity traditionally have recognized the presumption that the person who thus paid the consideration for the property did not intend a gift to the one in whose name the deed was taken, but instead intended that the property be held by the latter for the benefit of the former. Giving effect to such presumption of intention, courts of equity, in the absence of statutes requiring a different decision, generally hold that a "resulting trust" arises in favor of the person paying the consideration (unless this presumption of intention can be rebutted), and the nominal grantee is required to convey the property at the direction of the beneficiary of the resulting trust. In New York, and a few other states, this type of purchase-money resulting trust has been abolished by statute. H. Si.

**TRUST, INVESTMENT.** *See* INVESTMENT TRUST.

**TRUST COMPANIES.** *See* BANK FUNCTIONS AND OPERATIONS (*Special Services and Functions*); BANKING LAWS AND SUPERVISION (*Banking Laws*).

**TRUST RECEIPT,** a document evidencing the receipt of goods or securities by a person who does not have title thereto, and who agrees to return them, or to sell them and return the proceeds. Trust receipts are frequently necessary where banks make loans with securities or commodities as collateral. For example, when a bill of lading is held by a bank as security it usually must be released to the borrower in order for him to get possession of the goods or have them placed in a warehouse. A trust receipt is signed by the borrower and held by the bank until the borrower can substitute a warehouse receipt, or sell the goods and pay off the loan. Similarly, when a warehouse receipt is held by a bank it may have to be released in order for the borrower to process or sell the merchandise. The trust receipt gives possession of the goods to the borrower, but retains title in the bank. E. E. E.

**TRUST TERRITORIES.** *See* UNITED NATIONS.

**TRUTH,** the ideal perfection of knowledge. The kinds and degrees of failure to achieve this perfection constitute untruth.

The form of this idea which will inspire men's minds at a given time depends partly on what they most desire to know. Thus, for example, some, from Socrates onward, have sought moral truth by critical reflection upon ultimate human aspiration; medieval Christendom thought to attain religious truth by divine revelation reinforced by rational construction; modern man has concentrated increasingly on finding out the secrets of nature by empirical methods. What this variety has in common is the insight that truth can be reached only by bringing the mind into conformity with a reality which is independent of the will and desires of the knower.

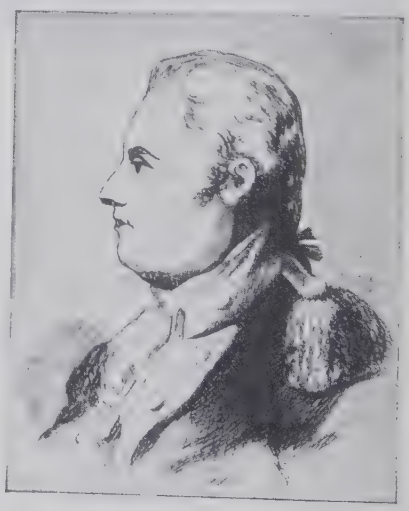
To specify this conformity more precisely in terms of a careful interpretation of the nature and methods of modern knowledge has been an important reflective task throughout the modern period. During the first half of the twentieth century three theories largely dominated the discussion, despite occasional significant dissent on behalf, usually, of some form of intuition (Bergson, Husserl). These theories may be characterized briefly as follows:

**Correspondence Theory.** A proposition is true if it corresponds to fact; false if it does not. Every proposition is thus true or false, even when it is not known to be true or known to be false. The relation of "correspondence" may be described as equivalence of formal structure of fact and formal structure of proposition, as in the case of a correct map. The test of truth must ultimately be a direct inspection of fact. As this is frequently impossible, much of our knowledge must be derived inferentially from propositions that can be tested directly.

**Coherence Theory.** Truth characterizes not propositions but knowledge, which is an achievement of logical inference and theoretical construction. Theory and fact interpenetrate, neither being external to the other, as the correspondence theory requires. The mind achieves truth in so far as its activities are controlled by the total logical tendency of available evidence. The ideal of coherence is thus a comprehensive system of judgment, every part of which implies and is implied by the whole. To be true, thought must be comprehensive, consistent, and necessary.

**Instrumentalist Theory.** Truth means neither correspondence to pre-existent fact nor coherence in an intellectually satisfying logical system, but successful guidance in action. However theoretical it may become, thought is still a tool or instrument produced by the organism to help it in practice. Ideas are regarded as essentially "plans of action"; the truth of an idea thus means its success in application, and its falsity means its failure. Ideas the acceptance of which would make no difference in practice are regarded not as false but as fanciful or meaningless. J. S. F.

**TRUXTUN, THOMAS** [trʌ′kstən] (1755-1822), American naval officer, was born near Hempstead, Long Island, N. Y., Feb. 17, 1755. He had elementary schooling and at the age of twelve went to sea. At fifteen he was impressed into the British navy and at twenty was master of a merchant vessel. In the American Revolution he became a privateersman and served on the *Congress,* the *Independence,* the *Mars,* and the *St. James.* He ranked fifth among the six captains in the new navy approved by Congress on Apr. 30, 1798. When the naval war with France began in 1798, Truxtun commanded the frigate *Constellation.* After two cruises he led a squadron of five ships stationed between St. Christo-



THOMAS TRUXTUN

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pher and Puerto Rico. On Feb. 9, 1799, he won his first celebrated victory, over the French frigate *L'Insurgente*. French casualties were 70, American 3. This success won him great acclamation at home. In December, Truxtun sailed for the same station, in command of nine vessels. After a two-day chase, on Feb. 1-2, 1800, the *Constellation* engaged *La Vengeance* for five hours, silencing its much heavier batteries. As Truxtun prepared to board, his vessel lost its mainmast and the enemy escaped. He received the thanks of Congress and a gold medal, and was unquestionably the hero of the naval war. For the remainder of the hostilities he commanded the *President*.

In 1801 Truxtun, aboard the *Chesapeake*, commanded the second squadron against the Barbary Pirates, but in 1802 he withdrew from command, which meant his resignation from the navy. Truxtun set splendid standards for the young American navy. He wrote *Remarks, Instructions, and Examples Relating to Latitude and Longitude* (1794); *Instructions, Signals, and Explanations Offered for the United States Fleet* (1797); and *A Few Extracts from the Best Authors on Naval Tactics* (1806). He died in Philadelphia, May 5, 1882.

T. R.

**TRYPANOSOMA.** *See* Protozoa.
**TRYPTOPHANE.** *See* Proteins.

**TSALDARIS, CONSTANTINE** [tsɑlθɑ′ris] (1884- ), Greek statesman, was born in Alexandria, Egypt, in 1884. He studied law and political science at the University of Athens and, between 1904 and 1910, at universities in England, France, and Germany. Returning to Greece, he established a legal practice and was elected to the Greek parliament. He was appointed a minister in Crete in 1920, but after the establishment of the Greek Republic in 1924 he indulged in counterrevolutionary activities and was arrested in 1926, serving seven months of a three-year prison sentence. In 1932 he was again elected to parliament, serving until 1936, when he became under secretary of state in General Joannes Metaxas' cabinet. His underground work during the German occupation of Greece in World War II finally forced him into exile.

Returning to Greece after the war, Tsaldaris became influential in the adoption of a pro-Royalist policy by the Populist Party. When the party won a plurality in the March 1946 election Tsaldaris became premier, and largely through his efforts the 1946 plebiscite on the monarchy resulted in a victory for the Royalists. He was reaffirmed as premier by King George II on his return to the throne, but agitation for liberalizing reforms and representation of the minority parties in the Greek Cabinet led to Tsaldaris' resignation as premier in January 1947. In the coalition government formed by Demetrios Maximos, Tsaldaris became deputy premier and foreign minister, posts he continued to hold when Maximos was succeeded in September 1947 by Themistocles Sophoulis, Liberal Party leader. In September 1950 Tsaldaris became vice-premier.

D. R.

**TSANGWU.** *See* Wuchow.
**TSARITSYN.** *See* Stalingrad (*The City*).

**TSARSKOYE SELO** [tsa′rskəyə syelɔ′], officially Pushkin, also called for a period Detskoye Selo (Children's Village), a resort town in the northern Leningrad Region of the Russian Soviet Federated Socialist Republic in the western Soviet Union, 16 mi. south of Leningrad. A Finnish village occupied the site in the seventeenth century, but when Peter the Great built Leningrad (then St. Petersburg) in the early eighteenth century he named the settlement Tsarskoye Selo and established it as a palace center. It remained a residence of the tsars until 1917, when Nicholas II and his family left there for exile. Under the Soviets the town became Detskoye (or Dyetskoye) Selo and later Pushkin, after the poet Alexander Pushkin, who was educated in the town. The great palaces and gardens were turned into resort establishments for children and workers. Occupied by the Nazis for over two years during World War II, these luxurious structures suffered enormous damage. The Catherine Palace or Great Imperial Palace was built between 1724 and 1756 in Baroque style and contained hundreds of magnificent halls, especially the famous Cameron Gallery and the beautiful chapel; gold, silver, mother-of-pearl, lapis lazuli, and amber were used lavishly in decorations. The Alexander or New Palace was built in the late eighteenth century. Surrounding the palaces were some of the most beautifully kept gardens, walks, and fountains in the world. All were ruined in World War II. The railroad to Leningrad opened in 1838 was the first laid in Russia, and electric lights were installed in 1887. Pop. (est. 1950), 50,000.

C. C. H.

**TSETSAUT.** *See* Indian Tribes, North American (*Western and Eastern Subarctic*).

**TSETSE FLY** [tsɛ′tsi], the name given to any member of the family Glossinidae, of the order Diptera. All the tsetse flies are of drab coloration, brownish or grayish. Their wings are tightly folded flat over their backs when at rest. The tsetse has a long proboscis, long parallel-sided palpi, and a stout arista on the third antennal segment differing from that of all other flies. The rays of the arista are restricted to the upper side, and each ray is plumose. African sleeping sickness, caused by *Trypanosoma gambiense,* is transmitted chiefly by *Glossina fusca* and *G. palpale,* while *T. rhodesiense,* causing a disease fatal to cattle and other animals, is transmitted chiefly by *G. morsitans.* Fossil tsetse flies have been found in America, and living specimens have been taken from airplanes arriving in South America from Africa. These flies are peculiar because their larvae develop to maturity, or nearly so, in the body of the mother before being deposited. Fortunately, they do not reach the adult stage unless the conditions are exactly right for their development.

C. H. Cu.

**TSHI** or **TWI.** *See* African Peoples.
**TSIMSHIAN.** *See* Indian Tribes, North American (*North Pacific Coast*).

**TSINAN** [ji′nɑ′n], the capital of Shantung Province, eastern China, situated 221 mi. south of Tientsin and 410 mi. north of Nanking. It was founded in the reign of Emperor Great Yü (2205-2197 B.C.) of the Hsia Dynasty. The original site was about 25 mi. east of the present city, which was developed during the fourth century. Tsinan was among the first cities opened to foreign trade by imperial decree in 1904. Two years later a foreign settlement, Hsi Kwan, was established west of the city for foreign traders; it remains the business center of the community. In World War II the city was taken by the Japanese on Dec. 27, 1937, and in the Chinese Civil War the Communists took Tsinan on Sept. 19, 1948. Tsinan is both the administrative center and the leading industrial city of Shantung Province. It is also an important distribution point for agricultural products, and many industries are closely associated with agriculture. Numerous factories engage in silk reeling and weaving, cotton spinning, flour milling, and extraction of vegetable oils.

Shantung silk is world famous. Educational institutions include the American-endowed Cheelo University. Pop. 500,000.
A. C. T.

**TSINGHAI (CHINGHAI)** [tshɪ′ŋhai′], also known as Koko Nor, a west central province of China, bordered by Sinkiang Province on the west, Sikang Province on the south, and Kansu Province on the east and north. It is a vast grassland of 262,236 sq. mi., with a 1947 population of 1,346,800. The provincial capital is Sining. The inhabitants of Tsinghai are largely Chinese of the Han race. Mohammedans and Mongols are the minority racial groups.

**History.** The Mohammedans came to China from Persia and Afghanistan during the T'ang Dynasty (A.D. 618-907), and the Mongols reached Tsinghai after the invasion of Tibet by the Western Mongols at the end of the sixteenth century. The Mongols in Tsinghai Province are divided into two leagues, the Koko Nor East Wing League and the Koko Nor West Wing League, having 29 banners (basic political divisions). The dominant language in Tsinghai Province is of the Northern Chinese Mandarin System. The Mongols in the northern part of the province speak a language belonging to the Western Mongolia System. Tsinghai for centuries had been dominated by nomad tribes until the latter part of the Han Dynasty (206 B.C.-A.D. 220), when a province known as Szeping was established there. When the Mongols conquered China (A.D. 1368-1644), Tsinghai was put under the jurisdiction of Kansu Province. In the earlier years of the Republic the province was divided into the Sining and Tsinghai administrative districts. In 1928 the two districts were merged into one, known as Tsinghai Province.

**Topography and Climate.** Forming part of the Tibetan Plateau, Tsinghai has an average altitude of 4,000 ft. above sea level. The Kunlun Range stretches eastward across the province, constituting the watershed of China's two greatest rivers, the Hwang Ho and the Yangtze. The 2,700-mi. Hwang Ho rises from the Khotun Nor (lake), at the northern hill of Bayenkala Mountain, a part of the Kunlun Range in the southern part of this province. The 3,400-mi. Yangtze springs from the Tagh-Ulan Mountain on the Tsinghai-Tibet-Sinkiang border, then flows in a southeasterly direction to the south of Bayenkala Mountain. Amne Machin Mountain, on the Tsinghai-Szechwan-Sikang border, is a continuation of Bayenkala Mountain. Its highest peak reaches 24,600 ft., one of the highest peaks in the world. In the northern part of the province, beyond the Kunlun Range, is a lowland called the Tsaydam Basin, irrigated by the Tsaydam River, an inland waterway. Among the great number of lakes in Tsinghai, the Koko Nor (Mongolian translation of Tsinghai, meaning "blue sea") is the largest salt lake in China, 1,600 sq. mi. Fed by 72 streams, the Koko Nor is situated at approximately 10,500 ft. above sea level. The average temperature at Sining is 12° F., with a maximum of 58° in the summer and a minimum of 9° in the winter. The weather is bitterly cold in the winter, but the sky is clear during much of the time. People wear fur or felt all seasons of the year, including summer. The annual rainfall is about 12 in.

**Economic Resources and Activities.** Agricultural activities are limited to the eastern part of the province along the valleys of the Hwang Ho and its tributary, the Hwang. About 82,500 acres of land are irrigated by these two streams and by a network of small canals. The chief crops are barley, wheat, potatoes, beans, and hemp. The Chinese constitute the farming population. The Mongols are engaged in animal husbandry. The vast grassland on the mountain hills and the Tsaidam Basin make possible the raising of cattle, horses, hogs, and yaks on a large scale. A woolen textile industry is a recent development in this province. The salt water lakes are an important source of salt supply for the neighboring provinces, Kansu and Ningsia. The province has but one modern highway connecting Sining with Lanchow in Kansu Province. Ancient caravan routes link Sining with Lhasa in Tibet, Anhsi in Kansu Province, and Erhchiang Chochiang in Sinkiang Province.

**Cities.** Sining, the capital city, is the gateway to Sikang and Tibet. The exports from Sining are wool, fur, hides, cattle, and salt, while the imports are sugar, tea bricks, silk, cotton, and porcelain. The city has a population of 15,000. Southeast of Sining is located a rich lamasery, accommodating 1,500 lamas. Huangyuan, east of Sining and west of the Koko Nor, at the upper reaches of the Hwang River, is an agricultural center where the annual ritual of sacrifice to the Koko Nor is performed. Tulan, at the eastern part of the Tsaydam Basin, is a market place for the Mongols from the 29 banners.
A. C. T.

**TSINGTAO** [tshɪ′ŋdau′], the third largest Chinese seaport, situated at the southern base of the Shantung Peninsula in northeastern China. It is 390 mi. north of Shanghai and on Chiaochou Bay, which forms an excellent harbor. The city has a modified continental type of climate, with cold winters and warm summers. Beyond it are low, rugged mountains. The chief industries include cotton- and silk-spinning mills and plants for processing peanut oil and egg products. Tsingtao's buildings and municipal services are among the most modern in the Orient, and its attractive beaches draw many tourists. The city and its harbor were developed largely by the Germans, who occupied Tsingtao in 1898 and forced China to grant them a 99-year lease as indemnity for the lives of two murdered missionaries. The Japanese forced withdrawal of the Germans during World War I, and at the Washington Conference of 1922 the city was returned to China. The Japanese reoccupied Tsingtao in World War II, but it was again returned to China at the war's end. The city was severely damaged in the Chinese Civil War before the Communists captured it in February 1949. Pop. 537,400.
A. C. T.

**TSINKIANG.** *See* CHUANCHOW.

**TSIN LING SHAN** [tshɪn′lɪŋ shɑ′n], a mountain range of central China extending eastward from the high plateau of Tibet. It is immediately south of the Wei and Hwang Ho valleys. The Tsin Ling is an eastern extension of the great Kunlun Range and reaches 20,000 ft. in height at the western end, decreasing to about 3,000 ft. before leveling off into a plateau in western Honan Province. In eastern China the mountains are called Siungerh Shan and Funiu Shan. The range separates the northern and southern areas of central China and also forms a climatic, cultural, and economic divide.
J. E. F.

**TSITSIHAR (LUNGKIANG)** [tsi′tsihɑr, lu′ŋjɪɑ′ŋ], the capital of Nunkiang Province in Manchuria, situated in the fertile valley of the Nen River, a principal tributary of the Sungari. An important trading point on the route between Mongolia and the Soviet Union, the city controls the river traffic from Mergen (Nenchiang) in Heilungkiang Province down to Sanchaho, the junction of the Nen and the Sungari. From Sanchaho down, river junks and light launches from Tsitsihar can ply the Sungari as far as Kirin (Yungki) in Kirin Province. Tsitsihar is connected by a 143-mi. railway with Peian, the capital of Heilungkiang

Province, and by a 160-mi. railway with Taonan in Liaopei Province via Angangchi, which is on the western section of the Chinese Changchun Railway, formerly the Chinese Eastern Railway, from Lupin (Manchouli) to Harbin. Highways from Tsitsihar reach out to Heilungkiang and Hsingan provinces as well as to the lands of the Mongol tribes. The river port at Tsitsihar was opened to foreign trade by an imperial decree in 1906. Built by the Manchus in the sixteenth century, the city was originally divided into two sections, one exclusively for the Manchus and the other for the Chinese, Mongols, and Korean settlers. The Chinese who sought to stay in the city were compelled either to adopt Manchu language, Manchu dress, and everything Manchu or to forego any resentment against their rulers.

The dominating economic activities around Tsitisihar are agricultural. Wheat, soybeans, corn, millet, and kaoliang are produced in abundance, and the province (Nunkiang) has the reputation of being the "granary of China." Transshipment of agricultural products by railways and along the Nen also plays a principal part in the city's economic life. Pop. 1950, 60,376. A. C. T.

**TSU ISLANDS** [tsu], a group of small Japanese islands situated between Korea and the northwestern coast of Kyushu Island, Japan, at 34° 25′ N. lat. and 129° 25′ E. long. The islands lie in the center of Korea Strait and separate Chosen Strait from Tsushima Strait. The group consists of two main and several lesser islands. Their total area is 260 sq. mi. and the maximum elevation 2,130 ft. The most important town is Izuhara, on the east coast of Kami Island. In the thirteenth century Mongol hordes under Kublai Khan overran the islands before reaching Japan. In May 1905 the waters off these islands were the scene of the famous Battle of Tsushima, in which Admiral Heihachiro Togo's fleet routed the Far Eastern fleet of Russia in one of the decisive engagements of the Russo-Japanese War. R. G. B.

**TSUTSUGAMUSHI FEVER.** *See* Rickettsia.
**TSWANA.** *See* African Peoples.
**TUAREG.** *See* African Peoples.

**TUATARA** [tu′ɑtɑ′rɑ], sometimes tuatera, *Sphenodon punctatum,* sole survivor of an ancient order of reptiles, the Rhynchocephalia. Its lizardlike appearance hides many primitive structural features. Its sage expression is also deceptive, for its brain is scarcely larger than a pea. A striking peculiarity is the third, or pineal, eye on top of its head, possibly sensitive to light, consisting of a transparent scale, lens, pigmented retina, and well-developed nerve connecting with the brain through an opening in the skull. The thick-set, 2-ft.-long tuatara is olive brown or dull yellowish, and has a crest of enlarged scales along the back and tail: its name means "having spines" in Maori. After having survived for millions of years, the tuatara was speedily exterminated by civilization on New Zealand, and sheep threaten its extermination on the few inaccessible islets off the mainland where it shares its nesting places with petrels. It feeds upon insects, primarily, and lays hard-shelled eggs that take a year to hatch. M. G. N.

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*TUATARA,* SPHENODON PUNCTATUM

**TUBA,** a name loosely applied to large, deep-toned, lip-blown musical instruments played with the aid of valves. Tenor, bass, and contrabass instruments of this type are made in a great many forms and pitches, and are given different names in different languages. The bass and contrabass tuba found in American orchestras are usually upright basses in the shape of a big cornet with the bell pointing upward; in military and concert bands the helicon bass, with circular tubing and bell pointing upward, and the sousaphone are more common. The sousaphone, a helicon bass coiled around the player, with a removable bell pointing straight ahead, was suggested by John Philip Sousa (1854-1932) as a means of securing a more powerful tone from the bass section of his band. W. Li.

**TUBATULABAL.** *See* Indian Tribes, North American (*Southwest*).

**TUBERCULOSIS** [tyubɜ′rkyulo′sɪs], a chronic infectious disease of man and animals, caused by *Mycobacterium tuberculosis* and characterized by formation in various body tissues of tubercles subject to caseous necrosis, with the resulting symptoms of fever, emaciation, and progressive loss of strength. The pulmonary form is also accompanied by cough, dyspnea, and hemoptysis.

**History.** Tuberculosis has been one of the scourges of mankind since ancient times. Throughout the centuries, it has been a chronic, world-wide, epidemic disease. The clinical picture was well known to the ancients and is excellently described in the writings of Hippocrates. The modern era in the history of tuberculosis began with the discovery of the tubercle bacillus by Robert Koch in 1882. The discovery of the X ray in 1895 by Wilhelm Roentgen was another landmark.

For reasons that are still not entirely clear, tuberculosis began to decline about the middle of the nineteenth century. In England and Wales the death rate dropped from 330 per 100,000 population in 1860 to 180 in 1900, and 60 in 1936. In the United States the death rate per 100,000 population fell from 181.8 in 1900 to 29.8 in 1949. Throughout most of continental Europe following World War II, there was a sharp rise in the death rate.

**Epidemiology.** Tuberculosis still remains a major health problem. At present, it is responsible for about one twentieth of all deaths and remains the chief cause of death from disease between the ages of 15 and 45 years. Tuberculosis occurs at all ages from infancy to old age; recent figures indicate an increase in the older age groups. In the United States the death rate among Negroes is about 2½ times the rate for whites. It is estimated that there are about 500,000 persons with active tuberculosis in the United States.

Tuberculosis spreads from one individual to another by

inhalation of air-borne particles of infected sputum. At one time, milk from infected cattle was a common source of infection, but this type has been almost completely eradicated in the United States, although it continues to flourish in other countries. Tuberculosis is not highly contagious; considerable contact must occur before active disease develops. Many people inhale tubercle bacilli, but the majority have sufficient resistance to destroy them. X-ray surveys of apparently healthy people show many with old, healed scars of tuberculosis; these individuals give no history of disease and are perfectly well.

Since inhalation is the common mode of infection, the lungs are the primary site of disease in the vast majority of cases. In the United States, pulmonary tuberculosis comprises about 95 per cent of all cases. However, the tubercle bacillus may invade all portions of the body, from skin to any of the internal organs; this occurs, usually, by spread from the lung infection. From the standpoint of public health, tuberculosis control is essentially control of pulmonary tuberculosis.

The tissue changes in the disease depend upon whether the individual has been previously exposed to tubercle bacilli. The first infection, of the primary or childhood type, represents the tissue reaction of an individual who has never been previously infected. Although more common in children, the primary type of infection is now seen at all ages. The initial site of disease occurs more frequently in the lower portions of the lungs. Characteristically, there is spread of the tuberculosis to the lymph nodes at the root of the lung. The first infection is usually benign and commonly undergoes healing without causing ill health. In infants, and occasionally in adults, the primary infection may progress to serious disease.

**Immunity.** The reaction of the body to subsequent infection is altered by the resistance built up as a result of the primary infection. Reinfection usually begins in the upper part of the lung and is frequently progressive, with cavity formation; there is no spread to the lymph nodes at the lung root. This is the common type of adult tuberculosis.

No completely effective antituberculosis vaccine had been developed by 1950. BCG (Bacillus Calmette Guérin), a vaccine which was first developed in France, has been widely used in continental Europe. This vaccine is composed of live bovine bacilli which have been attenuated by special methods. It confers partial and temporary immunity and cannot be relied upon to the exclusion of other measures; its use is primarily confined to those who are unavoidably exposed to active tuberculosis. BCG apparently confers the same order of immunity as a spontaneous primary infection.

**Diagnosis.** Since the method of spread of the disease is known, early recognition, with proper treatment and isolation, is the single most effective preventive measure. Pulmonary tuberculosis is usually an insidious disease, and there may be no symptoms in the early stages. As the illness progresses, such symptoms as chronic cough, weight loss, fatigue, hemoptysis, and night sweats develop. By the time definite symptoms have appeared, the illness is usually in a moderately or far advanced stage. Increased use of X-ray surveys of apparently healthy people leads to discovery of patients with minimal disease. In the unrecognized state, these individuals are a source of infection to their close associates.

Although it is of inestimable value, the X ray alone cannot always determine the activity of the tuberculous process. It will reveal the presence of lung disease, even of minimal extent. Subsequently, the determination of whether this disease is tuberculosis or nontuberculosis, active or healed, depends upon further examination, including studies of the sputum for tubercle bacilli.

The determination of sensitivity to tuberculin is also a helpful diagnostic test. A small amount of a material called tuberculin is injected into the skin. A positive result indicates that the individual has had a tuberculous infection. It does not indicate whether the infection is active or healed. The greatest value of the test lies in the fact that a negative result usually rules out the presence of tuberculosis.

**Treatment.** There is no specific cure for tuberculosis. The basis of all treatment is adequate bed rest; this is best carried out in a sanatorium where equipment and trained personnel have been gathered together. Geographic location of the sanatorium is of relatively little importance. The primary factors are adequate medical and nursing care.

A considerable percentage of patients, particularly those with minimal disease, will be cured by bed rest alone. Others, with more advanced disease, will require various types of lung collapse to aid in healing. More recently, in a small percentage of suitable patients, it has been possible to remove the diseased portions of the lung. In this manner, seemingly hopelessly ill patients have been restored to health.

During the last few years, several effective drugs have been developed. The best known of these is the antibiotic streptomycin. Others are para-amino-salicylic acid and the thiosemicarbazones. These drugs may produce toxic or disagreeable effects and should be administered under careful supervision. None of them is a cure-all for tuberculosis; they are valuable primarily as an adjunct to other well-established forms of therapy, such as bed rest and surgical methods.

**Rehabilitation.** The problem of rehabilitation is a most important one. Tuberculosis is a chronic, relapsing disease, and the danger of reactivation is always present, particularly during the first two years following discharge from a sanatorium. After the period of sanatorium care, the patient faces the problem of resuming normal life with all its responsibilities and strains. If this is done gradually, under medical observation, the chances are good that the patient will remain well. Adequate housing and good nutrition are also important factors. Co-operation between medical and social-service personnel is essential. Statistical studies indicate that good rehabilitation measures enable the former patient with arrested disease to resume a normal existence with an excellent prospect of remaining well. Rehabilitation facilities have not kept pace with the whole broad medical and social problem of tuberculosis, and much remains to be accomplished. H. R. N.

**TUBEROSE** [tyu′broz; tyu′bəros], a summer-flowering bulb, *Polianthes tuberosa,* of the amaryllis family, popular for its sweet-scented flowers. It is probably a native of Mexico, and is grown commercially in the United States as well as in Europe; but 80 per cent of the American crop (largely from North Carolina) is exported. The plant gets its name from the bulblike tuber, and grows from 2 to 3½ ft. high, bearing long, narrow leaves and large, waxy-white, double or single flowers, arranged in pairs on a terminal spike. G. M. Sm.

**TÜBINGEN, UNIVERSITY OF** [tü′bıŋən] (Eberhard-Karls-Universität), at Tübingen, Germany, founded in 1477 by Count Eberhard V of Württemberg. The reformed faith was accepted by the university in 1534, and three years later a Protestant Theological Seminary was established as one of the university's schools. Not until 1817 was a faculty of Catholic theology organized. The faculties in 1949 included evangelical theology, Catholic theology, jurisprudence

and political economy, medicine, philosophy, mathematics, and natural science. Several institutes are maintained by the university: the archaeological, which owns a collection of Egyptian antiquities as well as excellent Greek and Roman vases; and the geological and zoological exhibit, which houses the natural history collection, including valuable fossils of the Triassic and Jurassic periods. The university's library, founded in 1477, contained 612,000 volumes in 1947, including a particularly valuable collection on theology and the Orient. A. L. H.-Q.

**TUCANA** [tuke′nə], the Toucan (a tropical bird), a modern southern constellation, centered at right ascension, 23 hr. 40 min.; declination, — 67°. Though large, it is an inconspicuous group, with only one star sufficiently brilliant to be included in the third magnitude. Within its boundaries are the Lesser Magellanic Cloud, to the naked eye a hazy spot like a detached portion of the Milky Way, and the bright globular star cluster N.G.C. 104. J. H. P.

**TUCANO.** *See* INDIAN TRIBES, SOUTH AMERICAN (*Other Linguistic Groups and Tribes*).

**TUCHONE.** *See* INDIAN TRIBES, NORTH AMERICAN (*Western and Eastern Subarctic*).

**TUCKAHOE** [tʌ′kəho], a village in Westchester Co., in southeastern New York, 16 mi. north of New York City, of which it is a residential suburb. The village, settled before the Revolution and incorporated in 1902, is governed by a mayor and council. The New York Central Railroad serves the community. Although there is some light manufacturing, the principal industry in the village is a medicinal drug plant. Pop. 1950, 5,991.

**TUCSON** [tusɒ′n], a city in southeastern Arizona, the county seat of Pima Co., situated on the Santa Cruz River, about 110 mi. southeast of Phoenix. Tucson, a noted health and winter resort, is situated 2,376 ft. above sea level, surrounded by the Santa Catalina, the Tucson, and the Tanque Verde mountains. The climate is mild and dry, and even though the temperature rises above 100° F. during June and July the heat is bearable because of the low humidity.

The opening of the Mission San José del Tucson in 1768 on the city's site marked the founding of Tuscon, whose area was included in the territory acquired by the United States by the Gadsden Purchase in 1853. The small community was garrisoned, and in 1856 it was the scene of a convention that petitioned Congress for the right to organize the Territory of Arizona, which was formed in 1863. In 1862 Confederate troops occupied the town. From 1867 to 1877 Tucson served as the territorial capital. It was incorporated as a town in 1877 and chartered as a city in 1883, the charter being amended in 1929. A mayor, council, and city manager administer the city.

Educational institutions located in Tucson include the University of Arizona, a state school for the deaf and the blind, an Indian school, and numerous private schools. Exhibits of interest may be found in the Arizona State Museum, the Carnegie Library, and the cactus garden on the university's campus. The Carnegie Institution of Washington maintains a botanical laboratory in the city, and the United States Bureau of Mines has an experimental station there.

The district's scenic features include Saguaro National Monument, Tucson Mountain Park, Sabino Canyon, and Colossal Cave. The ruins of Fort Lowell are situated 8 mi. northeast, and near by are the restored San Xavier del Bac Mission, the Casa Grande Monument, and several Indian villages.

EWING GALLOWAY

*THE COURTHOUSE IN TUCSON, ARIZONA*

Transportation facilities are furnished by the American Airlines and the Southern Pacific Railroad, which maintains extensive repair shops in the city. There is little manufacturing carried on in Tucson, which is the wholesale distribution center of the area and the shipping point for the region's livestock, citrus fruits, and cotton. Pop. 1950, 45,454. S. D. M.

**TUCUMÁN** [tu′kumɑ′n], a city of northern Argentina and capital of Tucumán Province, situated on the Soli River about 680 mi. northwest of Buenos Aires. Tucumán is Argentina's chief sugar-producing center and its largest city north of Córdoba. It was founded in 1565 and developed as a typically Spanish town, with low, thick-walled houses built around inner courts. It was here, in 1816, that the first Congress of the Republic was held and Argentine independence was proclaimed. Pop. 1947, 152,508. S. G. I.

**TUCUMCARI** [tu′kəmkɛ′əri], a city in northeastern New Mexico, the county seat of Quay Co., situated 165 mi. east of Albuquerque, at 4,100 ft. above sea level. In 1901 the Chicago, Rock Island and Pacific Railroad ended beside a construction camp near Tucumcari Mountain, and a settlement was founded which was made a division point for the railroad. Quay County was organized in February 1903, and Tucumcari became the county seat. The local city government is administered by a council and manager. The primary occupation of the inhabitants of the region has been ranching. To develop the surrounding semiarid lands so that farming would be profitable, the United States Government in 1938 established the Tucumcari Project, an irrigation program, under the Bureau of Reclamation. It was estimated that 45,000 acres of land would be served by the Conchas Dam, 35 mi. northwest on the Canadian River, which was completed in 1939. The Bureau of Reclamation maintains offices in Tucumcari and operates a demonstration farm near by. The city is the shipping and retail trade point for the district. Its chief industrial establishments are the shops and yards of the Chicago, Rock Island and Pacific and the Southern Pacific railroads. Pop. 1950, 8,419. S. D.M

**TUDOR,** the name of a family of Welsh descent, five members of which occupied the English throne. Owen Tudor became Clerk of the Wardrobe to Catherine, the widow of Henry V. Whether he ever legally married her is doubtful, but they had five children, of whom the eldest, Edmund

(c. 1430-1456), was created Earl of Richmond in 1453 by his half-brother Henry VI. Edmund married Margaret Beaufort, daughter of the Duke of Somerset, and his only son, Henry (1457-1509), defeated and killed Richard III in 1485, and ascended the English throne as Henry VII. His hereditary claim to the crown was very slight, but he was declared legal king by Parliament. His son Henry VIII (1491-1547) was empowered by Parliament to leave the throne by will, and under it his three children, Edward VI (1537-1553), Mary (1516-1558), and Elizabeth (1533-1603) succeeded in their natural order. With Elizabeth's death without heirs, the throne passed to James Stuart, King of Scotland and descendant of Margaret, the eldest daughter of Henry VII.

E. R. A.

**TUDOR STYLE.** *See* ARCHITECTURAL STYLES.

**TUESDAY,** the third day of the week. In the Roman calendar the corresponding day was *dies martis,* and the same reference to war is conveyed by the origin of Tuesday. Tiw's day is derived from Tyr or Tir, the wrestler and the son of Odin, or Woden, the Norse god of war. According to the Edda, Tyr is a one-handed god. The gods devised a plan whereby the wolf Fenris could be captured by means of Gleipnir, a chain as smooth and soft as a silken string. The wolf consented to be bound only on the condition that one of the gods put his hand in Fenris' mouth as a pledge that he would be released. Tyr alone had courage enough to submit his hand. But when Fenris found that he could not break the cord and that the gods refused to untie him, he bit off Tyr's hand. The Talmud lists Tuesday as a lucky day because the third day of creation is described as: "God saw that it was good." Among the Hindus it is, together with Saturday and Sunday, an unlucky day on which no important business or long journey may be undertaken. In Greece and Albania it is also an unlucky day on which all kinds of enterprise are forbidden. In some Christian circles Shrove Tuesday, the last day before Lent, culminates a long series of carnival events. Special delicacies are prepared, as in Belgium and Great Britain, where the day is known as Pancake Day. It is celebrated by the British with cock-fighting, football, and throwing pancakes. In Northumberland and Scotland the day is called Fastern's E'en (Eve of Fasting), and elsewhere as Rope Pulling Day or Shuttlecock Day. Estonians serve a special Shrove Tuesday soup (pig's feet and dried peas or lima beans). Among the Finns it is a school holiday and pancakes are a featured dish. Among the French, Shrove Tuesday is the Mardi Gras carnival honoring the Fat Ox. Roman Catholics in the Netherlands observe the day with merrymaking and feasting. The chief delicacy is *worstebrood,* a hard-crusted bread with a center of spiced sausage meat.

A. L. H-Q.

**TUFA** [tu′fə], a highly porous calcareous spring deposit. It has the same origin as the more compact travertine. The term "tufa" has been used for siliceous as well as calcareous spring deposits, but most petrologists prefer "siliceous sinter" for such material. Tufa has also been confused with tuff, which is composed of pulverized volcanic ejecta. The outstanding locality for calcareous tufa in the United States is in the terraces at Mammoth Hot Springs, Yellowstone National Park.

K. K. L.

**TUFF,** the name applied to consolidated deposits of volcanic ash and other fine volcanic ejecta. The word "tufa" has been used as a synonym, but its usage should be confined to spring deposits. Most tuffs accumulate under water, so this material may be both igneous and sedimentary. Tuff is a light-colored, fine-grained, friable rock, usually visibly stratified. If coarser ejecta are present, the rock may be called an agglomerate or volcanic breccia. Tuffs are given various names, such as rhyolite tuff or andesite tuff, depending upon the character of the original magma. Sedimentary tuffs may contain intermixed nonvolcanic material; calcareous tuff (which may be fossiliferous) is an example of this mixing.

K. K. L.

**TUFTS COLLEGE,** an accredited, coeducational, nonsectarian, privately controlled university, on a 200-acre campus in Medford, Mass., 5 mi. from the center of Boston. The Medical and Dental Schools are in Boston. The charter was granted to the School of Liberal Arts in 1852, through the efforts and support of members of the Universalist Church. First instruction was given in 1855. Additional divisions were founded as follows: Engineering School, including the Bromfield-Pearson School, 1865; School of Religion, 1869; Graduate School, 1878; Medical School, 1893; Dental School (established as Boston Dental College in 1868), 1899; Jackson College, the school of liberal arts for women, 1910; Fletcher School of Law and Diplomacy, 1933; and Division of Special Studies, 1939. Affiliated with Tufts is the Bouvé-Boston School of Physical Education, the Boston School of Occupational Therapy, the Nursery Training School of Boston, the Museum School of the Boston Museum of Fine Arts, and the Forsyth School for Dental Hygienists. Through a co-operative program arranged by Tufts College and the Harvard Law School, law students at Tufts take a seven-year course leading to the A.B. and the LL.B. degrees.

Degrees offered are the A.B., B.S., B.S. in engineering, M.A., M.S., M.Ed., M.A. in law and diplomacy, M.D., D.M.D., and Ph.D. Navy and Air Force R.O.T.C. units are available. The local chapter of Phi Beta Kappa was founded in 1892. The well-equipped library features many special collections, including the Universalist Historical Society Library, the Theological Reference Library, the Library of Natural History and Biological Sciences, the Music Library, the Medical and Dental Library, and the Edwin Ginn Library of international law and diplomacy.

Scholarships and fellowships are available. There is also a loan fund. Many students earn part or all of their expenses. Students not living at home are required to live in college dormitories except with special permission. Additional housing for men is provided by the fraternities. *For statistics see* COLLEGES AND UNIVERSITIES.

J. R. To.

**TU FU** [du′ fu′] (712-770), also known as Tu Tzu-mei, one of the greatest Chinese poets, was born near Ch'angan, the Chinese capital during the T'ang Period. By the age of twenty-four he had made the Grand Tour of the Yangtze Valley; he then returned to the capital, but was rejected for the civil service at the Metropolitan Examination. From 735 to 746 he traveled in the north, making the acquaintance of Li Po and other men of letters. In 751 he enjoyed a brief moment of imperial patronage and was given a minor office in the Heir Apparent's entourage, not proportionate, however, to the ambition expressed in such poems as *Offered up to the Official Wei, My Senior.* On the eve of the rebellion of An Lu-shan (755-762) he left the capital and wrote *Chanting Thoughts as I Travel to Feng Hsien,* bemoaning his lack of recognition and lamenting the evil times. Here occurs his most famous couplet:

Within the red doors (of the rich) wine and meat spoil;
Out on the roads are the bones of frozen men.

In this poem he tells that his own little son had died of hun-

ger. In several poems he records the horrors of war (*The Tragedy of Ch'en T'ao*).

In 756 Tu Fu was captured by rebels, but escaped and was appointed censor by the Heir Apparent, now Emperor (757). He was, however, overconscientious in this post, and was cashiered. *Traveling to the North* tells of his return to his family and of their ragged and squalid condition.

In 758 Tu Fu held a post east of Ch'angan on the great military road, and here he recorded the sufferings of the people in wartime in six famous pieces, *The Conscript Officer at Hsin An* being the first.

In 759 he migrated with his family in search of a better life in Szechuan, and the next five years at his famous "Grass Hut" outside Ch'engtu were largely a period of peace and contentment. Here he wrote *River Village, Slowly Pacing, Reckless High Spirits,* and other poems. A quarrel with his patron in 765 caused him to flee down the Yangtze River, and in 770 he died at Leiyang, Hunan. His last poems included the autobiographical piece *Years of Strength Travel.*

Tu Fu's 1,400 surviving poems are a precise notation of everything he saw and felt, and they present a detailed history of his times. Less wild in fantasy than Li Po, his powerful imagination was focused by deep humanitarianism and by a fine sense of form. *See also* Li Po. H. Sh.

**TUGBOAT.** *See* Vessels, Inland Waterway.

**TUKUNA.** *See* Indian Tribes, South American (*Principal Linguistic Families*).

**TULA** [tu′lɑ], the name of both a governmental region and the city which is the administrative center of that region, in the west central Russian Soviet Federated Socialist Republic, in the Soviet Union.

**The City.** An industrial city, Tula is located 120 mi. south of Moscow, lying in a low valley on both sides of the Upa River, an Oka River tributary, where it is joined by the Tulitsa River. Discovery of iron and low-grade coal deposits in the area led to the establishment of its first gun factory in 1595, an iron factory in 1632, and the small arms factory fostered by Peter the Great in 1712, which continues in use. The city is an important communications center, and is the focus of five main rail lines. As the oldest Russian metallurgical center, Tula has factories producing arms, cutlery, and iron and copper goods, while the Tula wares, including the Tula samovars used all over the Soviet Union and the black enamel objects inlaid with silver, are famous. Other products are sewing machines, sugar, distilled spirits, leather goods, and foodstuffs. In addition to large production of apples and other fruits, there is considerable trade in apple nurslings. Pop. (est. 1950), 250,000. C. C. H.

**The Region.** Lying in the area known as the industrial center of European Russia, the region's 9,305 sq. mi. are bounded by the regions of Moscow on the north and east, Ryazan on the southeast, Orel on the south, and Kaluga on the west. It is situated on a plateau that is deeply incised by the Don River, and is in the transitional belt of forest and steppe, so that in the north it has poor podsolic soils, and fertile black earth in the south. Even though the climate is one of continental extremes, agriculture is well developed, with the largest acreages being devoted to rye, oats, buckwheat, sugar beets, and rubber-bearing plants (*Taraxacum*). Synthetic-rubber works and cement plants are operated. At Kosogorsk and Nova Tula foundries process the iron ore which comes from the southern part of the region. Coal from the near-by Moscow coal basin contributes to the industrialization. Pop. (est. 1954), 1,500,000. D. L.

**TULANE UNIVERSITY,** an accredited, coeducational, nonsectarian, privately controlled institution occupying approximately 100 acres in New Orleans, La. The colleges of liberal arts are co-ordinated, the women's division operating as the H. Sophie Newcomb Memorial College for Women. This institution started in 1834 as the Medical College of Louisiana. In 1845 the University of Louisiana was established by the state constitution and took over the medical college. The present name was adopted in 1884, when the state legislature transferred the university to the board of administrators of the Tulane Educational Fund. The various divisions of the university include the College of Arts and Sciences, the College of Engineering, the H. Sophie Newcomb College for Women, the Graduate School, the College of Law, the School of Medicine, the College of Commerce and Business Administration, University College (the evening division), the School of Social Work, the Middle American Research Institute, and the Summer School.

Degrees offered include the A.B., the B.S., the B.Ed., the B.Ed. in physical education, the B.Mus., the B.F.A., the B.B.A., the B. of Eng., the B.Arch., the LL.B., the M.C.L., the LL.M., the Master of Social Work, the M.D., the M.A., and the Ph.D. Tulane received a Carnegie Corporation grant for an experimental program aimed at developing a permanent university center for Latin American studies. The local chapter of Phi Beta Kappa was organized in 1909.

The well-equipped library features many special collections, among which are the Central American and West Indies collection on archaeology, linguistics, and exploration of the Middle American Research Institute; the William E. Gates collection of Mexican manuscripts, books, and pamphlets; the library of George H. Pepper on American Indians.

Scholarship offerings are generous and include awards to nominees of state senators and assemblymen, tuition grants to a limited number of citizens of Latin America, and tuition and maintenance awards to foreign students for graduate work in medicine. There is also a substantial loan fund. Opportunities for self-help enable nearly half of the students to earn part of their expenses. Some dormitory facilities are provided for female students and there is some housing in converted army barracks for male veterans. Additional living accommodations are provided by the campus sororities and fraternities. *For statistics see* Colleges and Universities. J. R. To.

**TULARE** [tulɛ′əri; tulɛ′r], a city in Tulare Co., in central California, located 45 mi. southeast of Fresno. The district was frequented as early as 1826, but the founding of the city did not occur until 1872, when the West Side Inn, which is an interesting historical landmark, was erected. In 1883 and 1886 two fires practically destroyed the community's business area. Incorporated as a city in 1888, Tulare has the council-manager form of government. Dairying is the most important activity of the vicinity, and Tulare is the shipping and processing center for the area's dairy products, cotton, fruit, grains, and livestock. Transportation facilities are provided by the Atchison, Topeka and Santa Fe and the Southern Pacific railroads. In Mooney Grove Park, 4 mi. east of Tulare, can be seen many of the large oak trees for which the territory is noted. Sequoia National Park is 35 mi. east. Pop. 1950, 12,445.

**TULAREMIA** [tulәri′mɪə], rabbit fever, or deer-fly fever, a highly fatal disease of wild rodents, especially rabbits, that can be transmitted to man by direct contact with infected animals or their carcasses; by the bites of infected animals;

by contact with water contaminated by bodies of infected water animals, such as water rats and beavers; by eating partially cooked meat of infected rabbits; or by blood-sucking insects. The antibiotics, aureomycin and chloromycetin, are effective in the treatment of tularemia. C. R. S.

**TULE** [tu'lɛ], the name given in the Pacific states to *Scirpus acutus,* a North American species of bulrush. A member of the sedge family, it is native to salt and fresh water marshes. From strong creeping rootstocks rise green, usually leafless stems, 3 to 9 ft. high, bearing at the tip many small flower spikes in crowded clusters. The stems furnish material for thatching and packing, and are a source of potash. Many thousands of acres of tule lands originally found in California have now been reclaimed for cultivation through drainage. J. C. Wis.

**TULE POTATO.** *See* ARROWHEAD.

**TULIP,** a large genus, *Tulipa,* of perhaps 100 species of bulbous herbs of the lily family, native to the Mediterranean region and Asia. They are erect plants with thick, crisp,

COURTESY OF ASSOCIATED BULB GROWERS OF HOLLAND

*COTTAGE TULIPS*

basal and stem leaves, and saucer or bell-shaped, usually erect and solitary flowers. Their easy culture, variety of color and form, long blooming period, and low cost have made them the most popular spring-flowering bulb for many centuries.

The garden tulip has been so extensively hybridized that its exact origin is unknown. There are now thousands of varieties, and their classification has become quite complicated. Among the types most commonly seen are: early flowering tulips, used mainly for winter forcing in greenhouses; cottage tulips, which bloom in May and have a wide range of solid colors; Darwin tulips, a later flowering group noted for their long stems and large flowers; breeder tulips, characterized by flowers in bronze and purplish tints; broken tulips, having vari-colored markings on the petals; parrot tulips, having twisted and slashed petals; lily-flowered tulips, bearing lily-like blooms; and double tulips, having many petals.

In recent years, there has been a growing interest in the wild species of tulip, many of which are adapted to the rock garden because of their small size.

Though tulips grow under very adverse conditions, they prefer a rich, sandy loam in full sun. They should be planted in late autumn, the bulbs being placed 6 to 8 in. or more below ground level, and mulched during the period when the ground is frozen. After blooming, the foliage must be allowed to wither and die back, even though it is unsightly, so that the bulb can store food for the following year. The bulbs can then be dug, dried, cleaned, and stored till fall, when they may be planted again, or they may be left untouched for several years.

Production of tulip bulbs has long been a major Dutch industry, and bulbs from Holland are exported in great quantities. In the first half of the 17th century, tulips became so popular, and speculation on the Dutch crop was so great, that fantastic sums were paid for single bulbs. During World War II, when no imports could be obtained from Holland, bulb growers began to raise tulips in the northwestern United States. J. C. Wis.

**TULIP POPPY,** a Mexican perennial herb, *Hunnemannia fumariaefolia,* similar to the California poppy but taller, growing as high as 2 ft. It is planted as an annual but requires a warm, sunny exposure. The flowers are yellow and measure 3 in. across. L. deF.

**TULIP TREE,** a tall, stately tree, *Liriodendron tulipifera,* of the magnolia family, common throughout the eastern United States from southern New England to southern Michigan, and south to central Louisiana and northern Florida. One of the largest trees of eastern North America, it attains its greatest size and abundance in the southern Appalachian Mountain region, where, in rich, moist, sheltered coves, it attains a height of 200 ft. and a diameter of 12 ft. The glossy leaves are truncated at the apex, ending abruptly as if cut off, but having a shallow notch. The large, greenish-yellow, tulip-like flowers develop into dry, cone-like fruits. It is planted for ornament in the eastern United States and in Europe.

The wood is known in the lumber trade as yellow poplar and poplar, and the sapwood is sometimes called whitewood. It is moderately light in weight, soft, weak, and low in stock resistance. Large quantities of the lumber are used for fur-

EWING GALLOWAY

*Tulip tree, with detail of twig, flower, leaf and fruit*

niture, boxes, and interior millwork. The large, round logs make high quality veneer, which is made into plywood for furniture.

The total stand of this wood in the United States has been estimated at 10,101,000,000 bd. ft., located mostly in Virginia, North Carolina, Georgia, and Alabama. W. D. B.

**TULLE.** *See* Textile Fabrics (*Silk and Rayon Fabrics*).

**TULLIVER** [tʌ′lɪvər], the middle-class English provincial family—father, mother, Tom, and Maggie—whose fortunes are the subject of George Eliot's *The Mill on the Floss* (1860). G. G. F.

**TULLUS AUFIDIUS** [tʌ′ləs ɔfɪ′diəs] (fifth century B.C.), Volscian general, according to Plutarch the opponent and rival of Caius Marcius Coriolanus in the Roman-Volscian wars of the early years of the Roman Republic. Upon Coriolanus' banishment from Rome, Aufidius welcomed him as an ally, and the two generals planned a joint campaign against the Romans. The bond between them was weakened, however, by Aufidius' jealousy, and when Coriolanus turned back from the walls of Rome instead of entering the city Aufidius took advantage of the clamor against him in the Volscian capital to have him murdered.

Shakespeare, following Plutarch's *Life of Coriolanus,* made Aufidius a principal character in his tragedy *Coriolanus.* The accuracy of either of these versions of early Roman history is highly questionable. R. V. L.

**TULSA** [tʌ′lsə], a city in northeastern Oklahoma, the county seat of Tulsa Co., situated on the Arkansas River, about 96 mi. northeast of Oklahoma City. The average mean temperature of the city is 62.6° F. It is located in one of the richest oil regions in the United States. In addition, there are natural resources of coal, natural gas, sand, and gravel. The Tulsa area has become known for its purebred herds of Hereford, Aberdeen Angus, and Shorthorn cattle. The principal products of the area are oats, corn, cotton, hay, peanuts, pecans, fruits, and vegetables.

Tulsey Town, as the community was first called, was founded about 1832 by a Creek Indian. The community occupied the site where the boundaries of the Cherokee, Creek, and Osage Indian nations met, and when it was incorporated in 1898 it was subject to the laws of these Indian tribes, for Oklahoma did not become a state until 1907. In 1900 the community had 1,390 residents, but by 1910 the population had risen to 18,182. This was caused by the important oil discoveries in 1904 and following years in the Tulsa district and the subsequent influx of oil prospectors and workers. Being in the heart of the oil fields, the city quickly became the center of oil activities, and it has become known as the Oil Capital of the World. Its real growth occurred between 1920 and 1930 when the population increased from 72,075 to 141,258. Tulsa has the commission form of government.

Tulsa serves as the transportation hub for the district. Daily flights are provided by the Braniff International, the Mid-Continent, the American, and the Continental air lines, and the Atchison, Topeka and Santa Fe, the Midland Valley, the Missouri-Kansas-Texas, and the St. Louis-San Francisco railroads furnish freight and passenger facilities. Not only is Tulsa the center of the vast oil operations, but it is also the financial, manufacturing, and commercial center of the region. The oil refineries are outside the city in West Tulsa and other points along the river. A large portion of the city's industry is allied with oil production and refining in the manufacture of oil-well equipment and petroleum products, in the publication of oil journals, and in oil technology. The factory output also includes scientific instruments, aircraft, castings, dairy products, packed meat, clothing and textiles, chemicals, glass, prefabricated houses, furniture, and clay products. Pop. 1950, 182,740. S. D. M.

**TULSA, UNIVERSITY OF,** an accredited, coeducational, privately controlled institution, affiliated with the Presbyterian Church. The main campus of approximately 40 acres is situated 3 mi. from the business center of Tulsa, Okla. Founded in 1894 as Henry Kendall College at Muskogee, Indian Territory, by the Presbyterian Church, instruction was begun that same year. The institution was moved to Tulsa in 1907. Reorganization took place in 1920, when the name was changed to the present form. The various divisions of the university were founded as follows: College of Arts and Sciences, 1894; College of Fine Arts, 1912; College of Petroleum Engineering, 1928; Downtown College, 1933; Graduate Division, 1934; College of Business Administration, 1935; and College of Law, 1943. The degrees offered include the A.B. and the B.S. in liberal arts; the B.S. in business administration, engineering, petroleum engineering, and chemical engineering; the M.S.; and the M.A. The Annual Accounting Conference, sponsored by the School of Business Administration, and conferences in marketing and management are held at the University each year. Special short courses in gas appliances are offered annually by the College of Petroleum Engineering.

The library features many special collections, among which are the Professor C. E. Kayser German Collection, the Alice Robertson Collection of Oklahoma documents and publications, the Professor Solon Shedd Geological Collection, the Harlin I. Smith Anthropology and Archaeology Collection, and the Haywood Collection of old manuscripts and original music for string ensemble.

Fellowships, scholarships, grants-in-aid, and student loans are available. Opportunities for self-help enable many students to earn part of their expenses. Dormitory facilities are available but limited in number. Additional living accommodations are provided for the members of some of the national fraternities on the campus. *For statistics see* Colleges and Universities. J. R. To.

**TUMBLEWEED,** a name applied to a number of North American prairie plants, the seeds of which are disseminated by the wind. In autumn, when the seeds are ripe and the leaves withered, the stems are broken off or uprooted by the wind and carried across open fields and along roadways, scattering seeds as they roll. The tumbleweeds are generally bushy weeds, growing to a height of 2 ft., or more, in the cultivated fields of central North America. Several of the most common species in this country have been introduced from Europe, including the tumbling mustard, *Sisymbrium altissimum.* Of the goosefoot family, the Russian thistle, or saltwort, *Salsola kali* var. *tenuifolia,* is found along the eastern shores of North America, and the bugseed, *Corispermum hyssopifolium,* in central and northern North America. The winged pigseed, *Cycloloma atriplicifolium,* another member of the goosefoot family, and the tumbleweed, *Amaranthus graecizans,* grow throughout the central United States. The name tumbleweed is also applied to the witch grass, *Panicum capillare,* and to the lance-leaved psoralea, *Psoralea lanceolata.* J. C. Wis.

**TUMION.** *See* Torreya.

**TUMORS,** literally "swellings," have been known to exist since ancient times. *Tumor* is one of the four primary signs of inflammation (*rubor, tumor, calor, et dolor:* redness, swelling, heat, and pain) listed by Celsus and Galen in Roman times, repeated during the Middle Ages, and even included in contemporary medical books. Today, however, the term is generally used to mean a neoplasm, that is, a noninflammatory growth of tissue which is not co-ordinated with normal body growth, serves no useful function, and often interferes with the normal body functions. Such a neoplasm, or tumor, may be either malignant or benign. Malignant neoplasms are commonly called "cancers." They grow more or less rapidly, infiltrate and destroy invaded tissues, and spread through the blood stream, lymphatic channels, and body cavities to distant sites of the body, setting up their destructive processes in these places also. This phenomenon of spread by the formation of new, separate centers of tumor tissue is known as "metastasis." Benign neoplasms more nearly resemble normal tissues, do not infiltrate or metastasize, and are frequently separated from the surrounding normal tissues by a fibrous capsule. Usually they grow slowly and do not harm the patient except by exerting pressure and damaging vital structures, such as the brain or lung, or by becoming ulcerated and infected.

Neoplasms, or tumors, occur in animals and plants as well as in human beings. Many different types have been found in all species of animals that have been sufficiently studied, and many plants develop analogous cellular reactions. Tumors have been recognized in fossils. A bony malformation which was probably a tumor was found in a dinosaur, and a mosasaur fossil of the Cretaceous period shows a tumor.

Tumors have been found in neolithic bones, in Egyptian mummies, and in the bones of pre-Columbian American Indians. Egyptian papyri, cuneiform tablets of Babylonia, and manuscripts of old India have descriptions relating to malignant tumors. Greek medical literature has many references to them, and Galen, writing in Rome in the second century of the Christian Era, has hundreds of passages on them. It is impossible to form any idea of the relative numbers and types of tumors in that day because of the lack of statistics and the fact that tumors often went unrecognized. While it is doubtful that the earlier civilizations had any clear understanding of their nature, Hippocrates distinguished between benign and malignant growths, and Galen was aware that malignant growths do not remain localized. Modern understanding of tumors has been made possible by the invention of suitable microscopes about 1820 and rests on the application of the cell theory to the study and classification of tumors by Muller, in 1838, and Virchow, in 1863.

Malignant tumors have shown a striking increase in incidence rate in the last fifty years. In the United States the cancer mortality rate doubled and by 1949 stood at approximately 139 deaths a year per 100,000 population (the mortality rate for benign tumors is in the neighborhood of four deaths per year per 100,000 population). This amounted to more than 200,000 deaths a year, about one seventh of the total from all causes. By 1949 cancer had risen from seventh to second place among the causes of death in the United States. It is estimated that about 300,000 new cases are diagnosed each year and that about 700,000 cases are under treatment. This involves an annual expense, for hospital costs alone, in excess of $100,000,000. About half of the rise in the incidence rate of cancer cases can be attributed to the increasing proportion of the population of older people, with their higher cancer rate. Part is also due to improved diagnosis, resulting in the recognition of many cases which might formerly have been missed. Constantly improving techniques of treatment, however, have resulted in a greater proportion of cases that can be cured.

Cancer of the lung has increased to the greatest extent (particularly in men), and cancer of the larynx, breast, prostate, esophagus, intestines, and pancreas have increased to a lesser degree. Cancers of the skin, stomach, liver, and uterus have decreased somewhat since 1940. The cancer mortality rate for women has been dropping since 1930, chiefly because of improved, earlier diagnosis and treatment. The greater increase of lung cancer in men has prevented a similar drop in the mortality rate for men.

Direct comparison with other countries is difficult and often impossible because of different methods of collecting statistics, incomplete diagnosis and reporting, and differing life spans. However, much higher rates than the United States' 139 per 100,000 are shown by the United Kingdom (193), France (172), and Germany (166). Holland shows a rate about the same as the United States; Chile's (87) and Japan's (77) are not much more than half that of the United States. Ceylon reports a rate of only 14, El Salvador, 21.4, and the Dominican Republic, 23.

## CLASSIFICATION

Tumors are divided into many types, which differ in growth characteristics, effect on the patient, and response to various types of therapy. The classification and naming of tumors is based primarily on cell type, malignancy, and organ of origin. Usually they depend on a microscopic examination of the tumor. Nearly every tumor studied can be recognized as being made up of cells resembling some normal tissue of the body, from which the tumor is presumed to be derived. As a group they are recognized microscopically by irregular and atypical cell type and cell arrangement. In general, the more malignant the tumor, the more pronounced are these two features. In some tumors, the atypicality is so great that recognition of the fundamental cell type is extremely difficult. The more malignant tumors frequently show invasion of the surrounding tissues and reversion of cell type to an undifferentiated, more embryonic appearance. Most tumors are made up of one type of neoplastic tissue plus nonneoplastic supportive connective tissue and blood vessels. The majority are named by a stem denoting the tissue type plus the suffix "-oma," which means "tumor."

Tumors within a single type do not necessarily have an identical appearance and do not follow identical clinical courses. All types, even of the most malignant tumors, show individual cases in which the patient remains free of tumor recurrence for many years. Some types, even of benign tumors, show a tendency to become more malignant as they grow older, especially if they are subjected to irritation. A number of attempts have been made to relate microscopic variation within a type to variation in clinical course. Of these, the most widely accepted has been the Broder classification, based primarily on the proportion of undifferentiated cells. Tumors occasionally show varying areas of different degrees of malignancy, from the histological standpoint. In these tumors it is usually the more malignant portions which are responsible for the formation of metastases, and it is thus against these more malignant areas that the treatment of the tumor is planned.

Classification is an exceedingly difficult and complex sub-

ject and despite the fact that it has been studied for approximately a century, there is still no agreement on a number of points. Some groups have still not been completely studied. Some types occur so rarely that only a few cases have been reported. Accumulation of knowledge on this topic requires the study, because of biological variation, of large numbers of patients with complete case follow-ups to the death of each patient, of whatever cause, and the performance of an autopsy to rule out unexpected features of the tumor growth. Such study has been hampered by the difficulty of keeping in touch with patients and, until recently, by the lack of autopsies on a large number of patients.

## CAUSE

No single cause of cancer has been found. Two general principles found are that most cancer-producing agents (carcinogens) are effective only if they are operative over a period of time and that tumors usually do not develop immediately, but only after the passage of some years (often 10 to 25), during the latter of which the tissues often show microscopic changes which may be called "precancerous."

**Chemical Causes.** The first elucidation of a cause of cancer was by Percival Pott, who in 1775 called attention to the scrotal cancer of chimney sweeps, caused by carcinogens in the soot. Nearly a century and a half later, in 1916, the first cancer to be produced experimentally was obtained by the application of coal tar to the skin of animals. Since then, a wide variety of chemical substances has been shown to be capable of producing tumors of many types. Cancer resulting from exposure to certain chemicals, such as crude paraffin oils, chromates, nickel, tars, and aromatic amines, has occupied the attention of industrial hygienists and necessitated control measures. Some cases of skin cancer developing in elderly persons are thought to be the result of tonics containing arsenic taken many years before. Several epidemiological and clinical studies have pointed to cigarette smoking as the cause of the increased incidence of cancer of the lung. Insecticides, food preservatives, and food-coloring agents are scrutinized for possible carcinogenic activity before approval by Federal agencies. The recognition and study of the action of chemical carcinogens in experimental animals is an active field of cancer research.

**Physical Causes.** Many cases of cancer have resulted from the action of physical agents such as sunlight, which can cause cancer in the exposed skin, particularly in individuals with fair or sandy complexions which sunburn easily. These tumors are common and occur most frequently in the hot, relatively cloudless areas of the South, where the sun's rays are more intense. Susceptible individuals who are much in the sun, such as carpenters, farmers, and sailors, may develop a succession of skin cancers over a period of years. In a rare hereditary disease, xeroderma pigmentosum, the skin is unusually susceptible to the carcinogenic action of the sun's rays. Most individuals with this disease develop many skin tumors early in life and finally succumb to them. X rays and radioactive substances are carcinogenic under certain conditions. They probably can cause most types of tumors, but cancer of the skin and leukemia are the most common. Many early radiologists developed these conditions before these hazards were understood. The development of osteogenic sarcomas in workers who painted watch dials with radioactive compounds attracted wide attention in the 1930's, and tumors have been produced experimentally by a wide variety of radioactive substances. Physical agents causing chronic irritation, such as snags of teeth, sometimes result in cancer. Instances of cancer after long exposure to heat are provided by cancer of the lip, formerly developing in those who smoked clay pipes, the stems of which became hot, and the Chutta cancer of India, developing in a group which smokes homemade cigars with the lighted end in the mouth.

**Hereditary Factors.** A number of types of tumor show some predisposition to run in families, but only a few human tumors have been definitely shown to be hereditary. All of these types also show sporadic nonfamilial cases. None is common, but the one that occurs most frequently is multiple polyposis of the large intestine. Polyps (small inpouchings of the intestinal wall) begin to appear when the individual is 15 to 25 years old. Hundreds to thousands develop in a single individual. A small proportion of the polyps gradually develop carcinomatous characters and the untreated patient usually dies at the age of 25 to 45 years. This condition is inherited as a Mendelian dominant trait. Polyps developing in other areas, such as the nose, are usually of an entirely different nature, usually are not true neoplasms, and only rarely become malignant. In multiple neurofibromatosis (von Recklinghausen's disease), many tumors, usually of nervous tissue origin, develop over the body. Retinoblastomas are rapidly growing malignant tumors developing in the eyeballs of infants and young children. They are thought to be due to a dominant factor which continally reappears as a result of repeated mutations. Xeroderma pigmentosum, mentioned above, is apparently due to an incompletely dominant gene and requires two factors, the inherited disposition and a physical factor, sunlight, for the formation of skin cancers. A number of animal tumors have been shown to be hereditary. A melanoma of fishes has been studied so carefully that the investigator can predict which cell will be the first to show neoplastic change. In other melanomas, several genetic factors are involved and the experimenter can juggle them so as to change the location and degree of pigmentation of the tumor.

**Viruses.** Viruses were early (1910) shown to be the cause of certain naturally occurring tumors in animals, but this has been demonstrated for only a few types. No human tumor, with the exception of the common juvenile wart, a quasi neoplasm, has been shown to be due to a virus, although recent studies with the electron microscope have shown virus-like particles in the blood serum of women with carcinoma of the breast.

**Parasites.** Certain parasitic diseases sometimes result in cancer, but through the medium of chronic irritation rather than as a direct carcinogenic effect. One of the early successful cancer experiments, in 1913, used parasites to produce stomach carcinoma in rats. Two oriental diseases of human beings probably belong in this category. Bilharziasis, a parasitic infestation of the bladder, sometimes results in cancer of that organ, and the group of parasites called liver flukes cause disease of that organ which sometimes eventuates in cancer.

**Hormones.** A number of animal experiments have shown that large doses of estrogen, a hormone produced by the ovary, can cause tumors, especially of the breast, ovaries, and uterus. In humans, functional tumors of the ovaries producing estrogens have been associated with, and presumably caused, cancer of the uterus in a number of cases. There is evidence that endocrine factors play a part in the development of human carcinoma of the breast and prostate.

**Miscellaneous Factors.** Obese individuals have a

slightly greater cancer mortality rate than normal persons, and underweight individuals have a lower rate. In animal experiments, underfed animals develop fewer tumors and develop them later than overfed animals. Some types of tumors show a poorly understood variation in incidence with differing social class and economic status. Breast cancer is more common in the higher economic groups. Statistical studies of women with breast cancer show that a higher proportion are unmarried than in the general population; those married have fewer children and their marriages take place at a later age. On the other hand, cancer of the cervix uteri is more common in women of lower economic groups and in women who have borne children. It is almost unheard of in celibate women and in Jewish women. Cancer of the pharynx, esophagus, and rectum is more common to brewers, tavern keepers, bartenders, and waiters. Cancer of the lung, lip, and mouth is more common on the lower economic levels. A number of pathological conditions, often minor in themselves, show some predisposition to develop into or cause cancer. Some of these are called "precancerous." Examples are keratoses of the skin, old scars (especially of burns including those from X rays), chronic inflammatory conditions such as varicose ulcers and draining sinuses, leukoplakia of mucous membranes, syphilitic plaques of the mouth, cirrhosis of the liver, gall stones, and (single) adenomas of the thyroid.

## CONTROL

**Public Health Measures.** Fifty years ago the subject of cancer was mentioned only as a depressing topic, for it was assumed that all persons with cancer died, despite every effort at treatment. This picture is not true at present because of early diagnosis on the part of both the patient and the doctor and because of improved methods of treatment. Some types of cancer show a high cure rate. The best results have been achieved in cancer of the skin. Even for this type, it is estimated that the cure rate could be increased from the present 85 per cent to about 98 per cent by the application of presently existing knowledge, mainly through education of the patient to seek earlier cure. Similarly, the cure rate of carcinomas of the uterus and breast could be increased to 60 or 70 per cent. Even when cure is impossible, great benefit has been achieved by the prolongation of a useful and comfortable life. The early suspicion of cancer by the patient and prompt treatment by the doctor are of the utmost importance. Symptoms which may indicate the presence of cancer are listed below. They are not always present when cancer occurs and some of them may be symptoms of other diseases or disorders.

Early Recognition of Cancer by the Patient

| *Site* | *Early Symptoms* |
|---|---|
| Breast | Lump. Irregularity in breast contour. |
| Larynx | Hoarseness. Pain and difficulty in swallowing. |
| Stomach | Vague and nonspecific decline in health. Discomfort in stomach region. Loss of appetite or distaste for food, especially meat. |
| Intestine | Change in bowel habits. Blood (often black and tarry) in stools. |
| Bladder, kidney, prostate | Blood in urine (often "smoky" urine). Frequent or painful urination. |
| Lung | Irritative cough. Mucoid, blood-tinged, or rusty-speckled sputum. |
| Uterus | Spotting of blood between menstrual periods, during menopause, or after menopause. |
| Skin | Appearance of a small lump or scaling area. Enlargement or change in appearance of a mole. |

In many cases cancers have developed beyond possibility of complete cure before they have produced symptoms recognizable by the patient. This is especially true of those located in internal organs such as the lungs, stomach, pancreas, and liver. They may have been entirely symptomless or may have been heralded only by a vague and nonspecific decline in health, a slowly developing weakness, a loss in weight, or an anemia. For that reason, routine physical examinations, as practiced at cancer-detection centers, may be one answer to the problem of cancer control. A microscopic examination of the various body secretions for desquamated tumor cells by the Papanicolau technique may enable a diagnosis to be made before a tumor can be seen on physical examination and several years before it has caused any symptoms. Recently, miniature X rays for screening tuberculosis have turned up a number of lung tumors, also long before they were large enough for the patient to be aware of anything wrong. Much research is being done to develop a simple, universally applicable test for cancer, similar to blood tests for syphillis and diabetes.

**Diagnosis.** Many tumors are diagnosed by the doctor and treatment planned on the basis of the patient's symptoms and his physical examination. In other cases, X-ray examinations, sometimes with the injection of opaque media, are necessary. Tumors in special sites may require various laboratory tests. Special instruments, such as the cystoscope, sigmoidoscope, and laryngoscope, permit direct visual examination of tumors in the bladder, lower colon, and other sites. Definite diagnosis usually depends on microscopic examination by biopsy before the operation, or frozen section during the operation, or complete examination of the tissue after the operation.

**Treatment.** Surgical treatment of tumors is constantly improving as study of cases discloses procedures which are most effective. In general, operations have become more extensive recently because of advances in our knowledge of the paths of spread of tumors and improvements in anesthesia, physiology, and pre- and post-operative care.

More powerful X-ray machines with greater penetrative ability are being used. The betatron, which produces streams of electrons which can be converted to very powerful X-ray beams, and the cyclotron, which produces streams of neutrons, are being studied to determine their value in tumor therapy. X rays are also used in treatment of a number of nonneoplastic diseases. The use of X rays depends on the fact that their lethal effect on tissues is more pronounced on tissues which grow rapidly (such as those in malignant tumors) and is stronger on some types of tissues than others. Various kinds of tumors differ greatly in their response, and most types which respond well at first do so to a lesser extent on repeated series of treatments. The problem is how to destroy or seriously damage the neoplastic cells without harming too greatly the neighboring normal tissues. This is more difficult in the case of internal tumors than for those located on or near the body surface. Radium, an element constantly giving off X rays (and other emanations), is of advantage in this regard because it can often be placed in the neoplastic tissue itself. The treatment of more widely diffused neoplasms, such as the leukemias, has been benefited by the large number of radioactive elements produced in the atomic energy centers. These elements can be incorporated into chemical compounds which are attracted selectively to the neoplastic tissue by its biochemical components or metabolic activity. The one most used has been radioactive phosphorus. Radioactive iodine has been effective in treatment of functional thyroid tumors.

Despite extensive studies, only a few chemical substances have proven of clinical value. Stilbamidine has been found to be attracted selectively to the neoplastic cells in multiple myeloma. A group of substances, the folic acid antagonists, are of benefit in many types of leukemia. Another group, the nitrogen mustards, has been shown to be of value, particularly in Hodgkin's disease and the leukemias. *See also* LEUKEMIA. D. J. S.

**TUNA** [tu′nə], large fishes of the family Thunnidae, found near the surface of warm and temperate seas. Related to the mackerels, tuna may be distinguished from them by a series of detached finlets on the caudal peduncle. They are wonderfully streamlined for maximum efficiency in speeding through the water and have grooves or depressions of the body into which the fins may fold. All are pelagic species which usually wander about the oceans in schools, feeding on other fishes. They attain a weight of over 1800 lb. and a length of more than 12 ft. There are four main genera of tuna listed in order of their commercial importance: yellow fin, *Neothunnus;* skipjack, *Katsuwonus;* albacore, *Germo;* and blue-fin, *Thunnus.* The blue-fin tuna, although widespread, is more northerly in distribution than other tuna and reaches a large size. One specimen which weighed over 900 pounds was caught off Massachusetts by rod and reel. These large blue-fin tuna are often called horse mackerel. All tuna are fine game fishes and of great importance commercially. About 150 million pounds were taken annually in recent years, practically all of which were canned. *See also* ALBACORE; YELLOW-FIN TUNA. E. C. R.

**TUNA CLIPPER.** *See* FISHING VESSELS.

**TUNBRIDGE WELLS,** a municipal borough and resort in Kent, England, about 29 mi. southeast of London, also known as Royal Tunbridge Wells. It owes its rise to the discovery of mineral springs in the vicinity by the third Baron North in 1606, and its popularity to the patronage of English royalty. Queen Anne, Beau Nash, Samuel Johnson, David Garrick, and Samuel Richardson were frequent visitors to the spa, making it one of the most popular resorts in England, particularly during the latter half of the eighteenth century. The springs are at one end of the Pantiles, or Parade, a covered walk lined with shops, bordering an avenue of lime trees. Pop. 1952, 38,750. A. W.

**TUNG** [tʌ′ŋ], a deciduous tree, *Aleurites fordii,* of the spurge family, native to eastern Asia and important commercially as a source of tung oil, which is obtained from the seeds. It is grown extensively in China and increasingly in Florida and other Gulf states. It reaches 25 to 40 ft. in height, bearing heart-shaped leaves and loose clusters of white, pink-centered flowers which appear before the foliage. The round fruit, about 3 in. in diameter, contains from 2 to 5 rough, thick-shelled, poisonous seeds. The tree begins to bear at 3 to 6 years, an average tree producing annually 20 to 50 lb. of nuts, which yield about 25 per cent of oil.

**Tung Oil.** Tung oil is produced from the seeds (nuts) of the fruit of the tung tree, *A. fordii,* and from the wood-oil tree, *A. montana,* both natives of China. For the 5-year period prior to 1938, China produced about 120,000 metric tons of tung oil annually, of which 88,000 tons were exported, 70 per cent going to the United States. This was China's most important export commodity. Exports from China were impossible during World War II, and this situation stimulated production in the United States, Brazil, Argentina, and elsewhere. In the United States, tung oil is now produced in Georgia, Florida, Alabama, Mississippi, Louisiana, and Texas; and production has amounted to from 8 to 15 million pounds annually.

Tung oil, as compared with most other drying oils, has a high specific gravity (0.940-0.943) and refractive index (1.5165-1.5200). Its analysis shows about 80 per cent eleostearic acid, 15 per cent oleic acid, and 5 per cent saturated acids. It turns to a solid gel on heating to 280°C. or above. The high content of eleostearic acid, which has three conjugated double bonds, accounts for the rapid drying by polymerization of the heat-treated oil to produce a hard, but elastic, waterproof film highly resistant to acids and alkalies.

Tung oil is used in the manufacture of protective coatings, such as paints and varnishes, in making insulating material for electric wires, printing inks, linoleum, oilcloth, brake lining, and also in the waterproofing of paper, textiles, and other materials. The leaves of the trees, the nuts, and the oil and press cake produced from the nuts all contain a poisonous principle which renders the oil inedible and the press cake totally unsuited for stock feed. The hulls of the fruit contain 2.0 per cent or more of potash. The ground press cake is a very satisfactory conditioner in mixed fertilizer. It is also used alone as a fertilizer and contains from 2.7 to 5.9 per cent of nitrogen, 1.0 to 1.8 per cent of phosphate ($P_2O_5$), and 0.9 to 1.9 per cent of potash ($K_2O$), depending on the conditions under which the fruit is grown and the amount of shell included in the cake. H. L. Cr.

**TUNGSHAN** or **SÜCHOW** [tʊ′ŋshɑ′n, su′jo′], a walled city in northern Kiangsu Province, eastern China, also known as Hsuchow. It is 160 mi. northwest of Nanking and is an important railroad junction. The city lies on the southern shore of Wei Shan Lake, and the old river bed of the Hwang Ho traverses it. The heavy silt of the low-lying area produces abundant crops, chiefly cotton, wheat, millet, and peanuts. Tungshan is also an important glass-making center, and has cotton and silk mills. The climate is temperate. Tungshan has long been a strategic point in China's military history. Toward the end of the Ch'in Dynasty (221-206 B.C.) the great military leader Hsiang Yu made it the capital of his kingdom. More recently it was the scene of two major battles. From Mar. 23 to May 19, 1938, Chinese defenders made a heroic stand against Japan's invaders; they scored the first great Chinese victory of the war, inflicting 30,000 casualties, before they were finally encircled and forced to withdraw. In the Chinese Civil War an engagement involving a million men was fought between Nov. 6, and Dec. 2, 1948, before Communists took the city. Pop. (est. 1947), 200,000. A. C. T.

**TUNGSTEN** [tʌ′ŋstən], symbol W (German *wolfram*), atomic number 74, at. wt. 183.92, density 19.3, m.p. 3,370° C., b.p. 5,900° C. Tungsten (Swedish *tung,* heavy, and *sten,* stone) was discovered by C. W. Scheele in 1781. It is the third member of Group VI-A of the periodic table, very closely related to molybdenum. It is a transition element, its atom having four completed shells of electrons (2, 8, 18, 32), a fifth incomplete shell of 12, and an outermost shell of 2. Tungsten forms unstable, bivalent compounds by giving up its two outermost electrons ($W^{++}$), but the most important compounds are derivatives of the trioxide, $WO_3$, especially those in which this oxide acts as the anhydride of an acid, such as $H_2WO_4$ or $xH_2O \cdot yWO_3$.

**Occurrence.** Tungsten is found in only a few materials in limited areas, usually associated with tin. The most impor-

tant ores are wolframite. (FeMn) $WO_4$, and scheelite, $CaWO_4$.

**Properties.** The properties of tungsten vary widely with its purity, method of production and treatment. It is usually gray to black in color, very heavy, very hard (4.5-8.0 on Mohs' scale), brittle, and nonmagnetic. It has a tensile strength about one-third that of iron, and has a low coefficient of expansion (about equal to that of Pyrex glass). Its melting point is the highest of any known element. When heated and worked, tungsten is extremely malleable and ductile. It oxidizes in air only at high temperature, and it is scarcely attacked by any single acid or alkaline solution; but a mixture of nitric and hydrofluoric acids, or fused hydroxides, is a fairly good solvent for the metal.

**Uses and Compounds.** The uses of tungsten metal are numerous and widely varied. In electrical equipment, it is used for the incandescent wire in light bulbs and electronic tubes, for tungsten arc lights, for contact points, for winding electric furnaces, for rectifier valves, for anticathodes in X-ray tubes, for electrodes in electrolysis equipment, and in the amplifiers for wireless communication. Other general uses include thermocouples, phonograph needles, gauze for filtering corrosive liquids, and for various applications in scientific instruments. Of the tungsten alloys, ferrotungsten is by far the most important. Both ferrotungsten and pure tungsten are added to steel to increase hardness, toughness, elasticity, and tensile strength. High-speed tool steel contains 18 per cent tungsten, 4 per cent chromium, and 1 per cent vanadium, or 6 per cent tungsten and 6 per cent molybdenum; these steels have vastly increased machine-shop output. Stellite is an extremely hard alloy of tungsten, chromium, and cobalt; it resists corrosion effectively and is used mainly for cutting tools. Only a few tungsten compounds are commercially important. Sodium tungstate, $Na_2WO_4 \cdot 2H_2O$, a white, crystalline powder soluble in water is used for water-proofing and fireretarding fabrics, for X-ray screens, and as a reagent for biological products and precipitant for alkaloids. From sodium tungstate are prepared the complex tungstates, such as the phosphotungstates and the silicotungstates. Tungstic oxide or tungsten trioxide, $WO_3$, tungstic acid, $H_2WO_4$, and ammonium paratungstate, $(NH_4)_{10}W_{12}O_{41} \cdot 5H_2O$, are produced in large quantity and used mainly for making tungsten powder. Tungsten carbide, WC, is extremely hard, and when properly cemented forms the valuable high-speed cutting steel known variously as Carboloy, Widia, or Carboram.

B. S. H.

**TUNGUS.** *See* Asiatic Tribes (*Ural-Altaic*); Altaic Languages.

**TUNHUANG** [tʊ′nhwɑ′ŋ], an ancient oasis city of northwestern Kansu Province, north central China, near the Sinkiang border, southwest of Anhsi. It was a great center of Buddhist learning in the fourth century and contains a world-famous collection of Buddhist arts and classics. It was also an important point on the ancient caravan routes from China to Turkestan. Twelve miles southeast of Tunhuang are the renowned Chien Fo Tung (Thousand Buddha Caves), carved into precipitous cliffs by monks A.D. 366 at the height of Buddhist influence in China. These remarkable grottoes, of which about four hundred remain, have hundreds of colored murals depicting sutra stories, ancient traditions, Buddhas, lesser deities, princes, and commoners. The temple Rei Ying Sze at Tunhuang, in 868, began to produce Buddhist sutras which are said to be the first known examples of woodblock printing. In 1035 the city fell to the Tangut nomads of the Hsi Hsia kingdom, who devastated it. The valuable classics and paintings were saved, however, by monks who sealed them within the temple walls. The treasured collections were not discovered until 1899. They consist of thousands of fresco paintings, sculptures, and classical volumes, some of which were removed to the Fogg Museum of Art at Harvard University. Pop. 1946, 33,013.

A. C. T.

**TUNIC** or **TUNICLE** [tyu′nɪk, tyu′nɪkəl] (Lat. *tunica, tunicella*), in ecclesiastical usage, a sack-shaped garment, now usually with sleeves, worn as the outer liturgical vestment of the subdeacon in the Western Church, and by bishops under the dalmatic and chasuble in the pontifical celebration of Mass. Of ancient origin, it was used universally by subdeacons at the end of the tenth century, and in the late Middle Ages generally by acolytes. The development of its form, material, color and use has more or less followed that of the dalmatic.

N. J. T.

**TUNICA.** *See* Indian Tribes, North American (*Southeast*).

**TUNICATA** [tyu′nɪke′tə], a group of exclusively marine animals, first described by Aristotle, possessing an outer protective tunic of cellulose around the commonly barrel-shaped body. All tunicates feed by drawing in water, which contains microscopic food organisms, through a wide circular mouth, the inhalant siphon. The water passes into the sievelike pharynx through gill slits and finally leaves the body by way of the exhalant siphon. The food particles are trapped by a thin sheet of mucus produced in a ventral groove, called the endo-style. The food mass passes into the esophagus and out through the alimentary canal, where digestion and absorption occur. This peculiar feeding mechanism is also found outside the group in *Amphioxus* and in the ammocoete larva of the lamprey.

Tunicates are divided into three primary types: the Ascidiacea or sea squirts, all attached to the sea floor and existing both as solitary and as compound colonial forms; the Thaliacea, delicate oceanic forms rarely encountered close to coastlines, drifting or swimming often at considerable depths but never associated with the sea floor; and the Larvacea (alternatively called the Appendicularia or the Copelata), minute free-swimming tadpolelike tunicates equipped with a chordate tail. A similar tail, consisting of central supporting notochord, dorsal tubular nerve cord, and lateral muscle bands, is the outstanding but transient feature of the larval form of the ascidians and of at least one of the thaliaceans. The tail structure, taken together with the presence of true gill slits in all adults, definitely associates the tunicates with the vertebrates, although the two groups have undoubtedly gone their separate evolutionary ways since the immense antiquity of Pre-Cambrian time.

All tunicates are hermaphrodites. The majority of ascidians, all thaliaceans, though not the larvaceans, reproduce not only by egg and sperm production but also by budding. Among the thaliaceans, budding may result in a hollow dirigiblelike colony drifting through the water, as in the luminous *Pyrosoma* of tropical and semitropical seas, or may form a chain of developing and growing sexual individuals towed by the parental nurse form and breaking off progressively from the end of the chain to become free individuals, as in *Salpa*. The tadpolelike larvaceans use their tails for swimming only occasionally; generally they float in a complex cellulose house secreted by their skin and used as a food-capturing structure, the tail acting to draw in the water.

The ascidians live attached to the sea floor, mostly in shallow water. Some are solitary individuals that grow to relatively large size attached to the upper sides of rocks, or imbedded in sand or mud; others form flat colonies produced by budding, with many small individuals united in varying degree, attached to the more protected undersides of rocks, corals, seaweeds, and even other animals. N. J. B.

**TUNING,** in music, a term having two meanings. In its general sense, the word refers to that adjustment of instruments to a given standard of pitch which is necessary before they can be made to sound acceptable, either alone or together. The tuning of pianos, violins, and other string instruments is accomplished by tightening or loosening the strings slightly to raise or lower their pitch. Wind instruments are tuned by similarly lengthening or shortening their tubes and thus the enclosed columns of air. Tuning also refers to the basic system of scale intervals employed in a piano, organ. or in abstract theory, as "mean-tone tuning." *See also* TEMPERAMENT, MUSICAL. W. Li.

**TUNIS** [tyu′nɪs], the capital of Tunisia, situated in the northern part of the country at the head of the Gulf of Tunis. The city is built on a hilly isthmus between three lakes. To the south lies Salt Lake, to the north Lake Ariana, and to the east the Lake of Tunis, across which is La Goulette, the city's port. Tunis has two sections: the old native city and the modern European city, which the French began building in 1893. The native city includes the Medina, with its several gates, the Herat or Jewish quarter, the suburbs of Bardo and Marsa outside the city proper, the Kasbah, native markets, and many mosques. The Djamā el Zitouna (Mosque of the Olive Tree) was founded in 732 by the Ommayads and serves as a Moslem university. The remains of many Roman and pre-Roman towns in the hinterland attract tourists. Especially interesting is the Roman aqueduct from Zaghouan to the site of ancient Carthage, which lies 12 mi. northeast of Tunis. Railroads connect the city with Algiers and Casablanca to the west and Gabès to the south. Chief exports are wheat, olive oil, phosphates, alfa grass, and iron ore. In World War II the city was repeatedly bombed by Allied forces before they captured it on May 17, 1943. Pop. 1946, 364,593, of whom 175,200 were Europeans. W. S. V.

**TUNIS, UNIVERSITY OF,** a Mohammedan institution of higher learning in Tunisia, which for thirteen centuries has been an educational center. In 1842 the school as it is now known was established with a faculty of 100 professors and assistants. Enrollment of 1,000 students was attained, 500 of whom received free maintenance. In 1870 the government reorganized the university along modern lines, and in 1875 a decree admitted courses in history, geography, geometry, and astronomy, which enlarged the basic program of theology, Moslem law, and Arabic literature. Demands for further modernization led in 1909 to student strikes and riots, supported by the Arab press in a vigorous campaign on behalf of a modernization program. As a result of this support, publication was suspended by the authorities in 1911. Between 1919 and 1926 the campaign was renewed and intensified, and in 1928 the commission of education introduced new courses for notaries. Student strikes have been frequent in intervening years. In 1954 the faculty numbered 950 and student enrollment was about 11,362. A. L. H-Q.

**TUNISIA** [tyunɪ′zhiə], a French protectorate in North Africa, bounded on the north and east by the Mediterranean Sea, on the southeast by Libya, on the southwest by the Sahara Desert, and on the west by the province of Constantine in Algeria. Including a part of the Grand Erg Oriental, the area of Tunisia is 63,616 sq. mi.

THREE LIONS

*Adobe housing of the honeycomb type, which once served as fortifications, is common in Médenine, southeastern Tunisia.*

**Physical Features.** Physically, the tertiary highlands of northern Tunisia are of complicated relief. They form short ranges and massifs which are at the eastern end of the Atlas system, about 4,000 ft. high, and show in their general trend the southwest-northeast alignment. These chains separate many fertile valleys, the most important of which is the Medjerda, between the Kroumirie and Mogod mountains. Where the highlands reach the sea they form bold promontories. North of the mountains is a narrow strip of lowland, and to the south is an upland region decreasing in elevation, gradually southward, to the Chott depression which is about 49 ft. below sea level. Near the Libyan borders the land rises again to 2,500 ft. The eastern shores south of Cape Bon are flat and sandy with shallow gulfs, such as the gulfs of Hammamet and Gabès, in front of which are the islands of Djerba, Chergui, and Kerkennah.

The climate of Tunisia is generally Mediterranean with mild, rainy winters and hot, dry summers. Precipitation decreases southward to the plateau region and the Sahara. In the north there are permanent streams, the Medjerda and Miliane; in the south the wadis do not reach the Mediterranean, but lose their water in the sebkhas, or shallow salt depressions, while the southern wadis in the Sahara generally are dry.

The most important river is the Medjerda, which is 228 mi. long. The temperatures in Tunisia vary from 52° F. to 79° F. The rainfall varies from 28 in. in the north to about 8 in. in the south.

**Flora.** As a result of heavy rainfall, the northern mountains are clothed in rich evergreen forest abounding in cork oaks. Toward the south, the olive tree becomes increasingly prominent, and on the plateau, due to insufficient rainfall (about 10 in.), grasses prevail, mainly alfa grass. To the extreme south there are oases and irrigated gardens where dates grow in profusion. In the northeast, including the

peninsula of Cape Bon, the soil is suitable for the cultivation of oranges and other citrus fruits. South of this the Sahel area abounds in olive trees, which are drought-resistant. In general, from north to south, there is a succession of vines, olives, and date palms, following the decrease in precipitation.

**Fauna.** Among the domesticated animals of Tunisia are horses, asses, mules, cattle, sheep, pigs, goats, and camels, the latter still being in general use among the merchants and tribesmen who traverse the Sahara. S. Van V.

**Economy.** The chief agricultural products of Tunisia are wheat (average yearly production: 650,000 tons), barley (350,000 tons), olive oil (70,000 tons), dates (43,000 tons), and fruits, including oranges, lemons, and apricots. Livestock includes sheep (3,500,000), goats (2,300,000), cattle (500,000), and camels (240,000). The cultivated area extends over some 12,000,000 acres, of which 1,700,000 acres are *habu* lands, or intransferable religious holdings, and 6,500,000 acres collectively owned tribal lands. Tunisians own 80 per cent of the total acreage in white and barley, 86 per cent of the 25,000,000 olive trees, 94 per cent of the sheep and cattle, and practically all the goats and camels. French interests are represented mainly by corporations occupying about 12 per cent of the productive land. The most important industry is mining. There are virtually inexhaustible deposits of phosphates in the south, particularly around El Kef and Gafsa. The yearly production of phosphates is about 2,000,000 tons. Iron ore (1,000,000 tons) and lead (38,000 tons) are extracted in the north. Other industries includes about 2,000 olive-oil mills, 120 food-paste factories, and 40 canneries for vegetables and fruits. Native handicrafts flourish, particularly those specializing in rugs, leather goods, and pottery. In 1953 foreign trade amounted to 100,000 million francs; imports (60,000 million francs) included machines, petroleum products, sugar, and textiles (75 per cent from France). Exports (40,000 million francs) were mainly wheat, phosphates, iron ore, and lead (60 per cent shipped to France).

Tunisia has 4,800 mi. of roads and 1,310 mi. of railway, one line linking the capital city of Tunis with Algerian centers to the west and with Gabès to the south. Tunis, Bizerte, Sousse, and Sfax are the most important ports.

*Sailboats tied up along the palm-lined waterfront at Gabès, on the Golfe de Gabès, an arm of the Mediterranean in eastern Tunisia*

FPG

**Population.** The native population consists of Arabs and Berbers, all of whom are Mohammedan and constitute the bulk of the population. The Arabic language is spoken primarily, but there are some places, particularly in the Kroumirie Hills, where the Berber dialects predominate. The population, which in 1946 was 3,230,952, was estimated in 1953 at 3,500,000, including a small group of 250,000 persons having generally French nationality but of either French or Italian origin.

**Government.** Tunisia is under the nominal rule of a bey, whose position dates from the period of Turkish control. The founder of the present dynasty was Husein ben Ali, elected in 1705. Since Tunisia came under the French protectorate in 1881 a resident general of France has supervised the administration of the native bey under the arrangements between France and Tunisia signed at the convention of June 8, 1883. But according to an agreement ratified by the French Assembly on July 9, 1955, and signed by the Bey on Aug. 27, 1955, Tunisia was granted internal autonomy, and on Sept. 29, 1955, the first all-Tunisian government was approved by Sidi Lamine, Bey of Tunis. For administrative purposes, the whole country is divided into 37 caidats, each headed by a Tunisian caid whose actions are to be supervised by a national assembly.

**History.** Tunisia was first settled by the Phoenicians, who established themselves along the coast and founded Carthage. After the Romans captured Carthage at the end of the Third Punic War in 146 B.C., North Africa was settled by the victors and became a province of Rome. In A.D. 439 the Vandals invaded and captured Carthage, but it was returned to Rome by Belisarius in 533-534, and was under Roman rule until the Arab conquest in the seventh century. The region passed into Norman control under Roger I of Sicily in 1158, but his rule ended in 1160, and the region was held by Arabs until the Turks drove the Spaniards, their chief rivals, out of Tunisia in 1574 and made it a Turkish province until 1705. In that year Husein ben Ali was proclaimed ruler of the province under the title of bey and founded a hereditary dynasty which still rules Tunisia.

In the nineteenth century British, French, and Italian imperialists viewed Tunisia with covetous eyes, and after the conquest of Algeria the French pressure on Tunisia was increased. At the Congress of Berlin in 1878, the British allowed the French a free hand in Tunisia in exchange for recognition of their position in Cyprus, and in 1896 Italy recognized the French protectorate over Tunisia.

At the outbreak of World War II, after declaring war on France, Mussolini hoped to acquire Tunisia. In the autumn of 1942 after the Allied landing in North Africa, Tunisia became a battlefield and was a theatre of operations for several campaigns between the Allies and the German Afrika Korps. In March 1943, the British succeeded in piercing the Mareth Line on the eastern borders. The Germans were driven back to the sea, and on May 7, 1943, the Allied forces captured Tunis and Bizerte. One week later Tunisia was restored to the French. After the war the Tunisians demanded thoroughgoing political reforms. For several years, however, the French refrained from taking any decisive step, until, in 1952, grave and widespread unrest broke out in the country. By the beginning of 1954, the situation had become critical and terrorism in the cities and armed attacks upon outlying settlements were rampant. On July 31, 1954, French Premier Mendès-France flew from Paris to Tunis and made a solemn promise that France would grant Tunisia full internal au-

BLACK STAR

*Natives of Djerba, an island in the Golfe de Gabès, taking water from a cistern in the courtyard of the Mosque of Houmt Souk*

tonomy. Almost at once terrorism ceased, and negotiations were started in Paris during the second part of 1954. By Sept. 29, 1955 the first all-Tunisian government had been approved by the French Assembly and the Bey of Tunis.

W. S. V. and G. E. L.

**TUNNELS AND TUNNELING.** A tunnel is an elongated underground excavation, chamber, or passageway. True tunnels are excavated, or driven (the general term for the process of tunnel construction), from one or more access points without disturbing the ground surface. Many underground structures, built in an open trench and then covered over, such as part of New York's subways, are also called tunnels, though they are not actually constructed by tunneling methods.

**History.** The history of tunnels goes back to the end of the Stone Age, when man first discovered how to use metals and began to tunnel into the earth for ore. Water tunnels or underground aqueducts date from pre-Christian times. Tunnels were usually wholly associated with mining until fairly recent times. Modern tunneling began when many early canals were connected by tunnels through intervening hills. The first on record is the 515-ft. Malpos Tunnel in France, completed in 1681. The first American tunnel was on the Schuylkill Canal in Pennsylvania, 18 by 20 ft. in section and 820 ft. long, driven in 1820. In 1831 the first railroad tunnel, built to portage canal boats over a mountain on railroad cars, was completed near Johnstown, Pa.

**Classifications.** Tunnels are classified according to use; railroad, subway, vehicle, water, sewer, pedestrian, drainage, river diversion, and power (hydroelectric) are the more common self-evident classifications. For construction purposes they are roughly designated by hard rock or soft ground, depending upon the kind of material encountered in driving. Except for refinements of interior finish, the classification or use to which the tunnel is to be put does not affect the driving procedure, since the construction operations are dictated by the type of ground in which the tunnel lies.

**Dimensions.** Tunnels may be circular, oval, or horseshoe in shape. Driven tunnels are seldom square or rectangular because structures of these shapes do not resist external pressures well. Although tunnels have been driven as small as 3½ or 4 ft. in diameter, such sizes are not economical because of cramped working conditions. It is cheaper to drive a 6-ft. tunnel, in which men can work freely, even though that size is larger than necessary for the purpose—to carry a certain amount of water, for example.

Tunnels of largest diameter in the United States are the 85-ft. double-deck vehicle bore under Yerba Buena Island, connecting the two sections of the San Francisco Bay Bridge, and the four 56-ft. tunnels driven for diverting the Colorado River around Hoover Dam during its construction, later converted to power tunnels and floodways. The longest tunnel in the world is New York City's Delaware Aqueduct, extending for 85 mi. from the Catskill Mountains to Hill View Reservoir in Yonkers. The longest tunnel driven solely from the two ends (known as portals) without intervening shafts, adits (horizontal or sloping shafts), or other points of access is the 13.1-mi. Alva B. Adams tunnel in Colorado, completed in 1946 to divert irrigation water from the west slope to the east slope under the Continental Divide. The longest railroad tunnel in the United States is the New Cascade, 7.8 mi., on the Great Northern Railway in Washington, followed by the 6.1-mi. Moffat Tunnel in Colorado.

SOME IMPORTANT TUNNELS OF THE WORLD

| *Name* | *Location* | *Length (Miles)* |
|---|---|---|
| VEHICLE | | |
| Broadway | Oakland, Calif. | 2.8 |
| Brooklyn-Battery | New York City | 1.7 |
| Caracas-LaGuaira hwy. | Venezuela | 1.1 |
| Chacabuco | Chile | 1.0 |
| Detroit River | Detroit-Windsor | 1.0 |
| Holland | New York-New Jersey | 1.8 |
| Liberty Tubes | Pittsburgh | 1.2 |
| Lincoln | New York-New Jersey | 1.6 |
| Mersey | Liverpool, England | 2.2 |
| Queens-Midtown | New York City | 1.3 |
| Sumner | Boston | 1.1 |
| Viella | Spain | 3.1 |
| RAILROAD | | |
| Apennine | Italy | 11.5 |
| Arlberg | Alps (Austria) | 6.4 |
| Chicago Freight | Chicago | 62.0 |
| Giovi | Italy | 6.0 |
| Hex River | South Africa | 8.0 |
| Hoosac | Massachusetts | 4.7 |
| Lotschberg | Alps (Switzerland) | 9.0 |
| Moffatt | Colorado | 6.1 |
| Mount Cenis | Alps (France-Italy) | 8.0 |
| Mount Royal | Montreal | 3.3 |
| New Cascade | Washington | 7.8 |
| Rimutaka | New Zealand | 5.5 |
| Rogers Pass | British Columbia | 5.0 |
| Severn | England-Wales | 4.4 |
| Shimizu | Japan | 6.1 |
| Simplon | Alps (Switzerland-Italy) | 12.3 |
| St. Gotthard | Alps (Switzerland) | 9.3 |
| Vosges | France | 7.0 |

*(Continued on following page)*

SOME IMPORTANT TUNNELS OF THE WORLD—*Continued*

| *Name* | *Location* | *Length (Miles)* |
|---|---|---|
| WATER | | |
| Abda Doukkala | French Morocco | 10.0 |
| City | Boston | 5.5 |
| City No. 1 | New York City | 17.7 |
| City No. 2 | New York City | 20.5 |
| Colorado-Big Thompson project | | |
| Alva B. Adams | Colorado | 13.1 |
| Pole Hill | Colorado | 5.6 |
| Colorado River Aqueduct | | |
| East Coachella | California | 18.3 |
| Iron Mountain | California | 7.5 |
| Monrovia No. 3 | California | 6.1 |
| San Jacinto | California | 12.8 |
| West Eagle Mountain | California | 5.0 |
| Whipple Mountain | California | 6.1 |
| Valverde | California | 7.2 |
| Delaware Water Supply | | |
| Delaware Aqueduct | New York | 85.0 |
| East Delaware | New York | 25.0 |
| Neversink | New York | 6.0 |
| Duchesne | Utah | 5.9 |
| Edisto River Tunnel | Charleston, S. C. | 18.5 |
| Hetch Hetchy project | | |
| Coast Range | California | 25.0 |
| Foothills | California | 16.0 |
| Mountain Division | California | 18.8 |
| Kohala | Hawaii | 15.0 |
| Koolau | Hawaii | 15.0 |
| Lake View | Chicago | 12.2 |
| Lerma | Mexico | 9.0 |
| Liberty Road-Patapsco | Baltimore | 10.0 |
| Manchester Supply | | |
| Bowland Forest | England | 10.2 |
| Haslingden | England | 5.3 |
| Walmersley | England | 6.0 |
| Mono Craters | California | 11.1 |
| Montebello | Baltimore | 12.6 |
| New Croton | New York | 29.5 |
| Olokeli-Makaweli | Hawaii | 15.0 |
| Pescheria | Italy | 49.0 |
| Quabbin | Massachusetts | 24.6 |
| Rio Quiros | Peru | 3.1 |
| Shandaken | New York | 18.1 |
| Stanislaus | California | 11.0 |
| SEWER TUNNELS | | |
| Detroit Sewer | Detroit | 10.0 |
| Manhattan Interceptor | New York City | 5.0 |
| Minneapolis Interceptor | Minneapolis | 15.2 |
| Philadelphia Interceptor | Philadelphia | 9.0 |
| Portland Interceptor | Oregon | 3.0 |
| Southfield Road | Detroit | 9.5 |

SOME IMPORTANT TUNNELS OF THE WORLD—*Concluded*

| *Name* | *Location* | *Length (Miles)* |
|---|---|---|
| SEWER TUNNELS—*Continued* | | |
| South Side Interceptor | Chicago | 13.4 |
| St. Paul Interceptor | St. Paul | 15.0 |
| Tequixquiac | Mexico | 7.0 |
| West Side Interceptor C | Chicago | 20.6 |
| HYDROELECTRIC PROJECTS | | |
| Ben Nevis | Scotland | 16.0 |
| Canon del Pato | Peru | 5.7 |
| Eklutna | Alaska | 4.4 |
| Errochty | Scotland | 6.0 |
| Feather River (2 tunnels) | California | 10.5 |
| Huntington-Sheve | California | 4.7 |
| Isere-Arc | France | 7.2 |
| Kemano | British Columbia | 10.0 |
| Moyopampa | Peru | 8.0 |
| Niagara | Ontario | 5.0 |
| Owens Valley (3 tunnels) | California | 9.5 |
| Pit No. 5 | California | 5.4 |
| Sunndalsora | Norway | 10.0 |
| Tasan | Sweden | 7.1 |
| Vinstra | Norway | 15.0 |
| Wadi Agrioun | Algeria | 5.2 |
| Ward (Florence Lake) | California | 13.5 |
| Waterville | North Carolina | 6.2 |
| SPECIAL | | |
| Rove Ship Canal | France | 4.5 |

*Allegheny tunnel on the Pennsylvania turnpike, one of seven mile-long vehicular tunnels through the Allegheny Mountains*

COURTESY OF CONSTRUCTION METHODS

## GENERAL TUNNELING PROCEDURE

Certain fundamental construction procedures apply to all tunnels. Where possible, the site is probed in advance by borings to reveal the nature of the ground to be encountered. These advance explorations, coupled with a study of the geology of the region, usually give a fairly accurate picture of underground conditions, though sometimes they prove to be inaccurate. The earth's surface is a complex mixture of many kinds of soil, and often the best of advance explorations will fail to reveal soft spots, faults (crushed internal slide zones), and underground watercourses. Every bit of material lying within the tunnel limits must, of course, be excavated and the spoil removed entirely from the bore. This spoil, whether it be hard rock or soft silt, is always known as muck. The walls and roof, except in very solid formations, must be shored or lined with protective steel or wood supports as the tunnel is advanced in order to prevent cave-ins. Sometimes in soft ground even the floor must be braced. The workings also must be ventilated and drained.

Except in rare cases where the tunnel will stand without support or lining, or where its use does not require lining (as in drainage tunnels), the excavated area is given a permanent lining. This is usually a concrete shell, sometimes heavily reinforced with steel rods. Final tunneling operations adapt the bore to its intended use. In vehicle tunnels the roadway must be installed, along with ventilation ducts and light and power lines. Railroad and subway tunnels must be equipped with track and signals. High-pressure water and power tunnels often receive an inner lining of steel pipe.

## HARD-ROCK TUNNELING

Driving tunnels through hard rock follows a general pattern of procedure. The rock is drilled and blasted, the muck is loaded and removed, the necessary temporary lining or supports are placed, and, usually, after all excavation is complete and the bore is holed through, the final lining is placed.

**Method of Attack.** Excavated parts of tunnels under construction are called headings. The end of the heading

where the advance is being made is the face. Tunnels are driven from one or both portals, from shafts sunk to the tunnel line, or from adits. Length of tunnel, topography, and speed requirements dictate the number of access points. Intermediate shafts or adits, spaced between the portals, provide points of attack for opening up additional headings, thus speeding up the work. Sometimes, for large and long tunnels where progress might otherwise be slow, a smaller tunnel, known as a pioneer bore, is driven alongside the proposed tunnel. Crosscuts connecting the pioneer and main bores offer many additional points of attack. The muck is removed through the crosscuts and the pioneer bore.

Many methods were formerly used in advancing the face. A popular method, known as "heading and bench," was to drive the top section somewhat ahead of the lower or bench section. Variations of this attack included driving the bottom part first, or carrying side and top drifts (small tunnel sections) ahead of the main face, then connecting these drifts across the face by enlarging operations that eventually removed the entire face. Today, however, owing to development of better equipment and temporary supports, most rock tunnels are driven by the full-face method, in which the entire tunnel area is advanced simultaneously.

**Drilling.** Blastholes, ranging from 1¼ in. to 2¾ in. in diameter, are drilled into the rock face with pneumatic drills, which have long since replaced the old hand drills and earlier power drills operated by steam. Compressed air for the drills is supplied through pipes and hose at pressures from 75 to 90 lb. per square inch, from compressor plants outside the tunnel. Modern drills, known as drifters, have automatic feed; that is, they force the bit into the rock automatically as the hole is chipped out. A mixture of air and water, also piped to the drill, is forced under pressure through the hollow center of the drill steel and bit into the bottom of the hole, to keep down the dust and to flush out the cuttings.

Drill bits are either forged to the drill-steel shank or rod or threaded to the ends of the rod. Drifters have a feed of as great as 48 in., that is, they can drill as much as 48 in. of depth in each run. As blast holes usually run from 4 to 16 ft. deep, drill steels must be changed to longer lengths for each feed of the drifter. In the past, bits, both forged and threaded, have been made of hardened steel, but since 1948 inserts of tungsten carbide, cemented into slots at the bit end, have changed drilling economics. Where steel bits stayed sharp only a few inches to a few feet of hole drilling, depending on rock characteristics, carbide bits drill 20 to more than 100 times as much hole. Like most steel bits, they may be resharpened.

The drifters, which weigh up to 250 lb. each, formerly were mounted close to the face on steel columns or bars wedged across the tunnel and were clamped to the bars for easy shifting to new drill-hole locations. In recent years the drill carriage, or jumbo, has replaced the slow, cumbersome column-and-bar mounting, even in small tunnels. The jumbo is a car riding on rails and carrying a frame at the back or tunnel-face end, upon which several drills are mounted. Until recently, drifter support has been provided by several short clamp-held bars. Now, booms with powered elevation and swing devices position drifters correctly for each hole. The jumbo also provides convenient platforms from which the holes can be loaded with dynamite for blasting. When a round of holes has been drilled and loaded, the drifters are folded back out of the way and the jumbo is pulled to a side track clear of blasting.

**Blasting.** Dynamite comes in various strengths and types, each suited to a particular hardness of rock. Types used for wet holes are waterproof. Paper-wrapped cartridges of dynamite, about 1¼ in. in diameter and 9 in. long, are tamped into the drill holes with wooden rods. The amount of dynamite placed in each hole varies widely with type of rock and the drill pattern. Some rocks can be blasted more economically with few drill holes and correspondingly heavy charges in each hole; other rocks are best suited to more holes and lighter charges.

COURTESY OF "CONSTRUCTION METHODS"

*Drilling equipment for driving rock tunnels is mounted on front end of carriage (jumbo) which is shoved against tunnel-heading face.*

Electric blasting has entirely replaced the old-time burning fuse in tunneling. An electric detonator or cap, about the size of a short lead pencil, is inserted in one cartridge in each hole, usually the second from the bottom. Wires from the cap lead out of the hole and are connected to a firing circuit. The remaining cartridges are fired by concussion from the primed cartridge, the one carrying the cap.

If all the holes were fired simultaneously, much of the blasting force would be wasted in counteracting the thrust between holes. Therefore the round is fired in short sequences, only a fraction of a second apart, known as delays. Usually the center of the face is drilled with sloping holes that meet inside the rock at the apex of a pyramid or cone. This forms the cut, or the center blast area. The cut, being wedge-shaped, is forced out of the face by the first blast, known as simultaneous or zero delay. Then the round of holes surrounding the cut goes off on the first delay, throwing the rock into the now open cut space. In turn, the surrounding holes go off in succession from the center outward in subsequent delays, which run as high as nine or ten in number. Delay shooting, by throwing the rock inward into already loosened areas, utilizes the full strength of the dynamite for pulling and breaking the rock and also reduces the distance it flies from the face. Since all the broken rock or muck must be picked up and loaded, reducing the amount of fly rock saves time and money.

**Mucking Out.** The process of loading and removing the muck is known as mucking out. Hand loading has been entirely replaced by power-shovel loading. In large tunnels the shovels are short-boom variations of standard crawler-mounted shovels, but a special type of shovel, popularly known as the mucking machine, has been developed for medium and small tunnels. It operates on a track and is powered either by compressed-air engines or electric motors. One type plows into the muck pile, scoops up a load, and tosses it overhead onto a belt conveyor discharging into a

car attached to the mucker. Another type scoops up a load, swings around, and dumps into a car.

Cars are side-dump type for easy unloading. A locomotive brings a string of empties, capable of holding an entire round of muck, to the face. In most tunnels there is room for only one operating track except at points temporarily widened for sidings, so that as the forward car is loaded it must be switched back into the train and an empty car placed at the head end. Switching is often done with a "cherry picker," a small hoist or crane that lifts an empty car clear of the train while the rest of the cars are pulled back out of the way. Then the "empty" is dropped at the head end and the newly arranged train is shoved up against the mucker. The locomotive, called the dinkey, is always at the rear end, toward the portal. Sometimes, temporary sidetracks or a system of portable passing tracks is used instead of the cherry picker.

Storage-battery electric locomotives are the most popular type. In long headings, small diesel engines are sometimes used, a procedure made possible by modern ventilating methods. The trolley-type electric locomotive, common in mines, is seldom used in tunneling because of the danger and bother in constantly extending the trolley wire. Diesel trucks recently have been used to haul muck in large tunnels. Scrubbers—water tanks through which engine exhausts bubble—reduce noxious gases.

**Timbering.** All bracing and temporary lining is known as timbering, because formerly all supports were timbers; now they are usually steel beams and posts. The timbering system varies, of course, with the condition of the ground. Sometimes only a few steel ribs set circumferentially against the roof and carried on steel posts will be sufficient to hold the ground. Recently, an inexpensive technique, roof bolting, has been developed to replace timbering, where rock is fairly stable. Long bolts are anchored in holes drilled radially into the roof. Holding large washers or plates snug against the roof, the bolts have the effect of pinning roof-rock in place. Elsewhere, in rock that is stable, but tends to slake off when exposed to air, a thin layer of sprayed-on cement mortar affords sufficient protection. For other projects, far more elaborate protection is necessary. This may consist of closely spaced ribs connected by steel plates to form a tight sheathing, or by cross beams for supporting heavy ground. In ground that may cave in, it is essential to back-pack the space between the timbering system and the ragged contour of the tunnel (rock never breaks smoothly) to provide a constant full-bearing on the timbering system. Wood blocks or pieces of rock are used for packing.

**Ventilation.** Dynamite explosions release clouds of noxious smoke and fumes and create much dust. The smoke and dust must be removed from the heading to afford safe working conditions, and fresh air must be supplied to the workmen. Modern ventilating methods have made tunnels as safe, so far as air is concerned, as air-conditioned offices. Large-capacity fans, located in the open air at portals or at tops of shafts, blow fresh air into the headings or draw foul air out through large metal or reinforced-canvas pipes installed for this purpose.

**Drainage.** Tunnels are usually wet, for they cut through underground watercourses and wet seams. All excess water flowing into the headings must necessarily be removed. A common practice is to install a series of electric or air-driven pumps at sump holes into which the water flows. The pumps are connected through check valves into a discharge pipe line leading to the portal or up the shaft to the surface. Many tunnel projects have been complicated by extremely wet conditions which call for special handling. At San Jacinto, on the Colorado River Aqueduct, a special pump room, complete with remote-control pumps and motors installed in a watertight chamber, was necessary to take care of deluges of water released from underground lakes. The workmen had to evacuate this tunnel when heavy flows were encountered; and the heading quickly filled up, with the water rising high in the shaft. At the Leadville Drainage Tunnel in Colorado an attempt was made to seal off a heavy flow of water by the usual method of drilling into the wet zone and forcing grout, a mixture of cement and water, into the wet seams. However, the water encountered was so cold that the cement would not set fast enough to block the flow. The contractor overcame this difficulty by including oats in the grout mix, which, upon becoming wet, swelled sufficiently to block the flow until the cement could slowly set in the cold water.

## SOFT-GROUND TUNNELING

Tunneling in soft ground follows the same general procedure as that for rock, except that drilling and blasting are eliminated. Usually, much more attention has to be paid to timbering and temporary lining, since soft ground is difficult to hold in place.

Excavation is by pneumatic spades or by power-pulled knives that slice the ground away. Loading of muck into the cars is frequently done by hand, for soft ground is usually too sticky to handle with power shovels. Sometimes the muck is thrown by hand onto a conveyor which loads the cars.

**Compressed-Air Tunneling.** Where a soft-ground heading requires continuous support of the walls, roof, and face, the compressed-air method is often used. A tight bulkhead of concrete or steel is built across the tunnel at portal or shaft to seal off the heading. Then, compressed air is pumped into the heading at pressures varying with conditions. Sometimes the pressure is as high as 48 lb. per square inch.

Workmen, materials, and cars enter and leave the compressed-air heading through locks in the bulkhead. These are simply long, cylindrical steel chambers, with one door opening into the pressurized heading, the other into the free air. The locks operate as follows: the door on the high-pressure side is closed, and the other door is opened to admit men or materials entering the tunnel. Then this door is closed, and air from the high-pressure heading is admitted

EWING GALLOWAY

*Sand hogs at work behind tunnel-heading face, removing muck*

to the lock through a valve-controlled pipe. When the pressure within the lock equals that in the heading, the door into the heading is opened. Access from high-pressure to normal air is just the reverse, though when men are "locking out" of the tunnel, the pressure must be reduced very slowly to permit excess nitrogen absorbed by the blood under high pressure to be released through the lungs. If decompression is too fast, the nitrogen bubbles may collect in restricted blood channels, such as leg and arm joints, resulting in a painful affliction known as the "bends." Recompression followed by very slow decompression is the only relief for bends. Air in the pressure heading is pumped in at a rate to maintain constant pressure, that is, at a rate to compensate for all leakage through the ground, which is considerable in some cases.

**Shields.** For very soft and wet ground, tunnel builders resort to the use of a shield. This device, first used by Sir Marc Brunel in 1818 in a tunnel under the Thames in London, has made many tunnel projects possible. All the railroad, subway, and vehicle tunnels under the Hudson and East rivers at New York City have been driven by the shield method.

The shield is essentially a huge steel cylinder, slightly larger than the outside diameter of the tunnel to be driven. The front half is divided into compartments, usually sealed off by hydraulic gates that can be opened to admit muck from the face. The front or cutting edge carries an overhanging hood; the rear or tail end is open. Within the tail is a series of hydraulic jacks which propel the shield, shoving it ahead into the face.

Continuous primary lining, consisting of curved cast-iron or fabricated-steel segments, must be used in shield operation. These segments, which build up into a complete, tight ring of lining, are flanged at the sides and ends so that they can be bolted together. Lining segments are usually 30 in. wide, so that the completed ring of lining makes up 30 in. of the tunnel. The new ring of lining is always erected within the protecting tail of the shield.

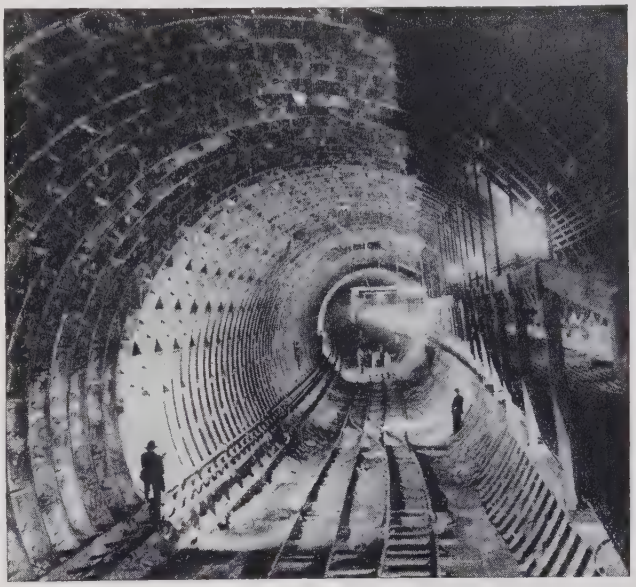
**Cycle of Operation.** The cycle starts after a new lining ring has been erected. The jacks are extended, pushing against the front-end face of the lining. Since hydraulic pressure operating the jacks is as high as 6,000 lb. per sq. in., the series of jacks can exert a powerful shoving force, which slowly pushes the shield ahead. During the shove the gates are opened and the displaced muck oozes into the working chambers much as tooth paste is squeezed from its tube. The ribbons of muck are cut into chunks with wire loops, dumped onto belt conveyors, and loaded into cars. Each forward advance is 30 in., the width of one ring of lining.

After the shove is completed, the jack pressure is reduced so that it is just sufficient to hold the shield in place. Then segments for a new ring are brought into the shield and are hoisted in place one at a time by an ingenious hydraulic-operated erector arm. As each segment is placed, the shoving jacks in that area are retracted, leaving a clear opening for the new segment. When the segment is placed and bolted to its neighbors, the corresponding jacks are again extended under low pressure to hold the shield steady. Because end joints of the segments are radial, special key sections with parallel ends are required to close each ring.

After the ring is complete, the shoving cycle is repeated. The tail of the shield always extends back beyond one ring, so that the workmen are protected by the shield or the completed primary lining. The shield is guided during the shove by varying the pressure on individual jacks. Hydraulic pressure for the jacks comes from a special pump, known as an accumulator, located outside the tunnel; and the hydraulic fluid under high pressure is carried to the shield through thick-walled piping.

### CONCRETE LINING

Most tunnels receive a permanent concrete lining, from 6 to 15 in. thick, which is placed after excavating has been completed. Usually the floor, or invert, is placed first; then concrete for the walls and roof is placed in a single operation.



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*Fully lined tunnel is left behind as working shield advances. Rings are curved cast-iron segments bolted together. Platform, at right, is the flying gangway for emergency escape to the tunnel safety lock.*

Traveling steel forms are commonly used for concrete lining. These are built up into sections, as long as 40 ft., to the contour of the desired inner surface. The forms ride on rails and are moved ahead as concreting progresses. They are of two general types, telescoping and nontelescoping. Those of the first type, used when rapid progress is desired, are collapsible to the extent that a section can be telescoped ahead through a section remaining in place while the concrete in the latter hardens. The nontelescoping type is just sufficiently collapsible to permit the section to be freed from the newly placed lining and moved ahead. This operation is much slower, because the form cannot be moved until the section just poured has hardened.

Usually, concrete for the lining is mixed at the surface and hauled to the forms in dump cars. Sometimes the mixer is placed right at the forms, mounted on rails to travel ahead as operations progress. In such cases the aggregate and cement are dry-batched at the surface and delivered to the mixer in properly proportioned charges.

Two methods are in common use for getting the mixed concrete into the narrow space between the form and the tunnel walls and roof. One is to force the mix into place through a pipe by means of a special reciprocating pump. Another method is to shoot the concrete through a pipe with bursts of high-pressure air by means of a pneumatic gun. In both cases the concrete is delivered at the crown and flows around the form into the sidewalls. Pipe sections are removed, or the whole assembly is withdrawn, as the form fills up.

H. W. Ri. and R. H. D.

**TUNNEY, JAMES JOSEPH (GENE)** (1897- ), American pugilist, was born on May 25, 1897, in the Green-

wich Village section of New York City. He was educated at parochial schools and at La Salle Academy. In World War I he joined the United States Marine Corps and served overseas. Tunney first achieved boxing fame in Paris in 1919, when he won the light-heavyweight championship of the American Expeditionary Force. Returning home the same

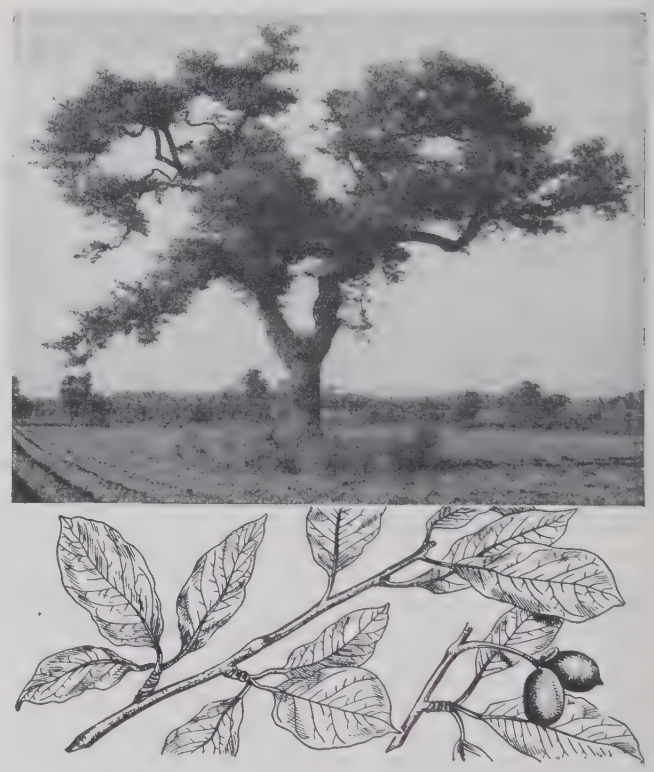
*GENE TUNNEY*

INTERNATIONAL NEWS PHOTO

year, he began his professional career. In 1922 he won the world light-heavyweight title after defeating Battling Levinsky and Georges Carpentier. He later relinquished the title to enter the heavyweight division. Tunney was first matched to fight Jack Dempsey for the heavyweight championship in Philadelphia on Sept. 23, 1926. At that time he had engaged in 60 professional bouts, winning 30 by knockouts, 14 by decisions, and losing only one; the rest were no-decision fights. He lost to Harry Greb in 1922, but Tunney later defeated Greb. In his Philadelphia fight with Dempsey, he won the decision and the championship. At a return bout at Soldiers Field, Chicago, on Sept. 22, 1927, Tunney again was awarded the decision, although many spectators believed he would have lost had Dempsey promptly retired to a neutral corner, when he knocked Tunney down for the famous "long count." He retired from the ring in 1928 and entered a business career. During World War II, as lieutenant commander and later commander in the United States Naval Reserve, he directed the athletic and physical fitness program for the navy. In 1948 he became president of the Gold-Uranium Corporation. G. Q.

**TUPELO** [tu′pəlo], a city in northeastern Mississippi, the county seat of Lee Co., situated about 150 mi. northeast of Jackson. Incorporated in 1872, the city has the aldermanic form of government. Tupelo's economic activities are primarily concerned with the processing of the area's produce, which includes corn, cotton, sweet potatoes, and fruit, dairy products, and livestock. The St. Louis-San Francisco and the Gulf, Mobile and Ohio railroads serve the city. Pop. 1950, 11,527.

**TUPELO,** a name commonly given to an important genus, *Nyssa,* of deciduous trees with a purple or dark blue plumlike fruit. Of the six species, two are found in southern Asia, and the remaining four in the eastern United States, three of which are commercially important. The black tupelo, *N. sylvatica,* also known as the black gum and the pepperidge, occasionally attains a height of 100 ft. It grows from southern Michigan to eastern Texas, and east to the Atlantic Coast, while its variety *biflora,* called swamp tupelo or sour gum, a somewhat smaller tree, is found mostly in the Atlantic Coastal Plain, from Delaware and Maryland to Florida and Texas. In early autumn, these trees are very conspicuous because of the bright red and purple tints of their foliage. The water tupelo, *N. aquatica,* sometimes 100 ft. in height, grows in swamps of the Atlantic Coastal Plain, from Virginia and Florida to Texas, and north in the Mississippi Valley to southern Illinois. Tupelo wood is heavy, hard, and strong; and, because of its close, uniform texture and interlocked grain, which prevent splintering under heavy wear, it is much used for factory floors and platforms. It is used also in building shipping containers and furniture. Tupelo should not be confused



TET BORSIG

*Black tupelo, Nyssa sylvatica, with detail showing leaves and seed pods*

with the tulip wood. The total stand of tupelo saw timber in the United States has been estimated at 14,216,700,000 bd. ft., located mostly in the Gulf states. W. D. B.

**TUPI-GUARANÍ.** *See* INDIAN TRIBES, SOUTH AMERICAN (*Principal Linguistic Families*).

**TUPINAMBA.** *See* INDIAN TRIBES, SOUTH AMERICAN (*Principal Linguistic Families*).

**TUPPER, SIR CHARLES** (1821-1915), Canadian statesman, was born in Amherst, Nova Scotia, July 2, 1821. Educated in Nova Scotia, he later studied medicine at the University of Edinburgh in Scotland. He received his degree in 1843 and returned to Nova Scotia to practice medicine. He became interested in politics and in 1855 was elected to the Nova Scotian Assembly, where he represented Cumberland County for twelve years. From 1864 to 1867 Tupper was premier of Nova Scotia.

Tupper was one of the leaders of the Canadian Confederation movement, and was instrumental in bringing Nova Scotia into the union in 1867. He represented Cumberland in the Canadian House of Commons from 1867 to 1884 and was a member of the Conservative cabinet from 1870 to 1873. Tupper became a leader of the party during the period from 1873 to 1878 when it was in opposition. A year after the Conservatives were returned to power in 1878, Tupper became Minister of Railways and Canals; under his supervision final arrangements were made for the construction of the Canadian Pacific Railway, which was completed in 1885. Tupper was named High Commissioner for Canada in 1883 and, except for fifteen months as Minister of Finance in 1887-1888, retained that office until 1896. During that time he represented Canada at international conferences in Washington, Vienna, and Paris. In 1896 Tupper became prime minister, but when the Conservatives were defeated in the elections of that year he resigned the office. He remained in the House of Commons from 1896 until his defeat in 1900. In January 1901 he retired from the leadership of the Conservative Party. Tupper died at the age of 94 at Bexley Heath, Kent, England, Oct. 30, 1915. He is buried in Halifax. C. B. F.

**TUPPER LAKE,** a village in Franklin Co., in northeastern New York, in the Adirondack Mountains, situated on Tupper Lake and the Raquette River, about 90 mi. northeast of Utica. The village, which was incorporated in 1902, is administered by a mayor and board of trustees. It is the site of a United States veterans' hospital. Near by is the New York State American Legion Mountain Camp. Of interest are the Mount Morris Observatory and Litchfield Castle. The New York Central System provides transportation facilities for the community, which is a year-round resort. The surrounding region is dotted with numerous lakes on which are located many popular winter and summer resorts. Located in a large lumber area, the local industries produce pulpwood, lumber products, and plastics. Pop. 1950, 5,441.

**TURA, COSIMO** [tu′rɑ] (c. 1432-1495), Italian painter, founder of the Ferrarese School, was born at Ferrara about 1432. The first mention of him as a painter is in a document of 1451, when he was working for the family of Este. In 1458, he was officially made painter to the Ferrarese court, and the ducal patronage continued throughout his career until his death in 1495. Tura's work shows an interest in architectural detail and perspective, like that of his contemporary, Andrea Mantegna, as well as a well-developed technique and brilliant color. His frescoes, done for churches and other buildings in Ferrara, have largely disappeared, but an *Annunciation* painted on organ shutters in the Ferrara cathedral still survives, and other examples of his work are preserved in London, Paris, and Rome. B. C. G.

**TURANOSE.** *See* Sugar Chemistry (*Oligosaccharides*).

**TURBELLARIA.** *See* Animal Systematics; Flatworms.

**TURBERVILE, GEORGE** [tɜ′rbərvɪl] (c.1544-c.1597), English poet and translator, was born in Dorsetshire, the son of Henry Turbervile and nephew of Bishop James Turbervile. His family is the one later represented in Thomas Hardy's *Tess of the D'Urbervilles.* He studied at Winchester, at New College, Oxford, and at the Inns of Court. All of his published work appeared between 1565 and 1575. He translated into English verse Ovid's *Heroides,* Mantuan's *Eclogues,* Mancinus' *De Quatuor Virtutibus,* and ten narratives, which appeared in his *Tragical Tales* (c. 1574), from Boccaccio, Bandello, and Plutarch; his two handbooks of sport, *The Booke of Faulconrie, or Hauking* (1575) and *The Noble Arte of Venerie, or Hunting* (c. 1575) also contain much translated material. Turbervile's original poems show the influence of Tottel's *Miscellany,* of Erasmus' *Adagia,* and of various Classical authors. They contain the first collection of Classical epigrams in English, the first extended poetic sequence in honor of a beloved lady, and three lengthy epistles from Russia, descriptive of that country. The circumstances of Turbervile's death are unknown. J. E. H.

**TURBINE** [tɜ′rbɪn; tɜ′rbain], a machine for converting the kinetic energy of a fluid in motion to mechanical energy. The turbine comprises essentially a bladed rotor (curved blades mounted on a shaft) and a casing, mounted with suitable ports, which encloses the rotor. The ports permit the intake and outflow of the fluid, as required. Classification of turbines is based upon the actuating fluid employed, such as water (hydraulic), steam, or gas.

### STEAM TURBINES

A steam turbine is a rotary prime mover that converts the energy of steam into mechanical work or power. The main parts of the turbine are the casing, nozzles, and blading on a rotor. These are suitably arranged to guide the steam for the energy transformation and to obtain useful work from the turbine shaft. Externally-generated steam is piped to the turbine. The pressure and heat energies of the steam are converted into velocity energy, or kinetic energy, in the nozzles. The high-velocity steam from the nozzles impinges on the curved blades fastened to the periphery of rotors (disks centrally located on the shaft). It imparts energy to the rotor by producing a tangential force on it. This force is available to turn the rotor and produce useful mechanical work from the rotor shaft.

**History.** The first recorded use of the ability to obtain work from heat was found in the manuscripts of Heron of Alexandria (second century B.C.) His aeolipile, or ball of Aeolus, illustrated in Fig. 1, consisted of a hollow sphere supported by two tubes above a steam generator in such a manner that the sphere could rotate between the supports. Two open pipes with an L-shape issued from the sphere. These pipes were diametrically opposite each other and midway between the supports. The steam passed through the

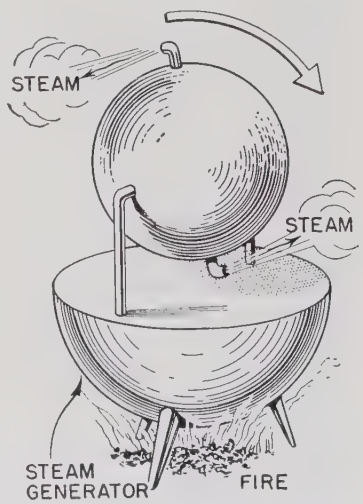



*Fig. 1—HERON'S AEOLIPILE REACTION TURBINE*

supporting tubes into the sphere and issued from the pipes. The resulting reaction on the pipes created a force that turned the sphere on its axis.

In 1629, Giovanni Branca described a device in which the steam issued as a jet from a boiler and impinged upon the vanes of a horizontal wheel (Fig. 2). The forces produced by the impulse of the steam on the vanes turned the wheel.

The principles of the turbine were neglected during the next two centuries. However, the knowledge and use of the energy of steam were exploited in the development of the steam engine. Richard Trevithick in England, about 1800, attempted a "whirling-arm engine" (a reaction turbine of the Heron type) but did not use the steam efficiently enough to compete with the steam engine. In 1831, William Avery patented a similar turbine in the United States. About fifty of Avery's turbines were used in sawmills, and one was installed in a locomotive.

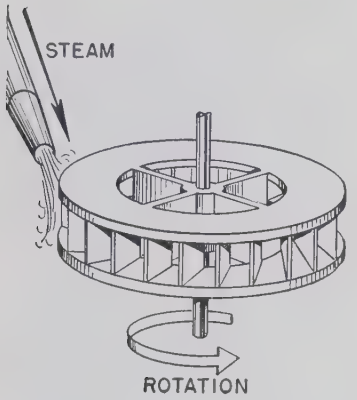



*Fig. 2—BRANCA'S IMPULSE TURBINE*

Others experimented with turbines but had little practical success until 1884. In that year, in England, Charles Parsons invented a practical form of reaction turbine. Carl Gustaf de Laval devised a successful impulse turbine of the Branca type in France in 1889. From this period, the advance of the turbine as a practical prime mover was rapid. A Parsons turbine was installed in the yacht *Turbinia* which drove her at a maximum speed of 34.5 knots in 1897. The success of this unit, together with performance information obtained from complete tests, established the turbine as a prime mover.

In the United States, George Westinghouse (1846-1914) realized the advantages of the high-speed rotary drive. He acquired the American rights to the Parsons turbine in 1895, and secured the services of Francis Hodgkinson of the Parsons staff as a development engineer. The first Westinghouse turbine, a unit of 300 kilowatts capacity, was built to drive an electric generator for use in the Westinghouse manufacturing plant. Electric motors were then substituted for the numerous small steam engines of the plant, wires were used instead of steam pipes, and greater flexibility was obtained. This application rapidly expanded with larger sizes of turbines and generators.

Major developments of turbine types were made by others. In 1896, A. C. Rateau devised the multistage impulse turbine to enable efficient operation at lower rotative speeds than had previously been possible. In the same year, Charles Curtis substituted a single stage of velocity compounding for several stages of pressure compounding. As these and later refinements were made, the output from a single shaft increased.

**Nozzles and Blading.** The pressure and heat energies of steam are converted into velocity energy by expansion of the steam through one or more stationary nozzles in the turbine case. The nozzles are set at an angle to the plane of motion of the turbine blading to direct the steam to the blading on this path. In some designs, the nozzles are formed by stationary blading.

The turbine blades are curved in the direction of the steam flow, and are straight, perpendicular to the direction of flow. The impulse blade (Fig. 3*A*) is symmetrical about its center line parallel to the plane of the rotor. The steam, while passing through the blade, remains at essentially the same velocity relative to the blade. The steam pressure is the same entering and leaving the blade. The reaction blade (Fig. 3*B*) is nonsymmetrical. The blading and passages between the blades are so designed that the steam velocity relative to the blade is increased on passing through the blade with a corresponding pressure drop through the blade.

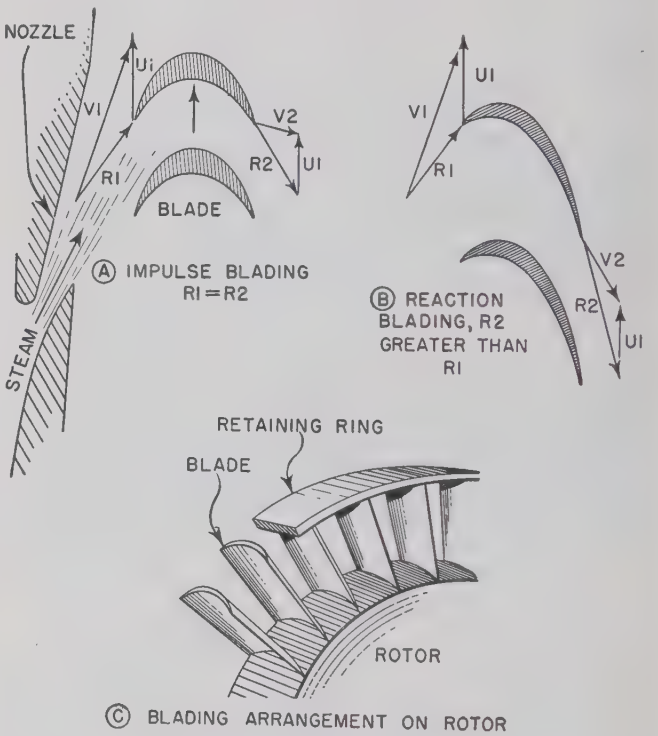



*Fig. 3—TURBINE BLADING*

*(V1) Steam velocity issuing from nozzle; (V2) Absolute velocity of leaving steam; (U1) Blade velocity; (R1) Steam velocity relative to blade, on entering blade; (R2) Steam velocity relative to blade, on leaving blade.*

**Staging.** Turbines are usually designed for direct drives of equipment at usable speeds. The rotor and blade speeds are limited by the strengths of the blading material to resist the action of the centrifugal forces of rotation. In order to utilize the steam velocity in the blading efficiently, the turbine must be multistaged, that is, must have more than one nozzle ring and more than one row of blading. By incorporating a series of nozzle rings and blades, the energy is transformed in steps with a partial steam expansion from the initial pressure to the final pressure in each step. In all staging, the cross-sectional area of steam flow increases in each stage. Larger nozzles and longer blades are required to take care of the increased steam volume, due to expansion.

Simple pressure staging (Rateau type) consists of sets of nozzles and blades of the impulse type. The steam expands in each nozzle bank in increments. In velocity staging (Curtis type), the pressure reduction is accomplished in one nozzle bank. The exit steam from the first row of moving impulse blades is redirected by stationary blades to act on a

second row of moving impulse blades. The velocity energy is utilized in steps in each set of moving blades. In re-entry velocity compounding, the steam is redirected to the same row of blades by helical or sinusoidal channels in the casing.

Staging in a reaction turbine is accomplished by stationary converging blades between rows of moving blades. These redirect the steam to maintain the same absolute entrance velocity to each set of moving blades.

Large turbines are usually made up of successive stages of combinations of the different staging types, depending upon the operating conditions.

**Steam Cycles.** *Rankine Cycle.* A turbine that operates on the Rankine cycle (Fig. 4*A*) receives steam at the line pressure and temperature. The steam flows through the turbine with no steam loss, other than that due to unavoidable leakage, and with no additional heat added to the steam.

*Reheat Cycle.* In the *reheat cycle* (Fig. 4*B*), the steam, after passing through the initial stages of the turbine, is brought out to a heat exchanger where additional heat energy is added. It then returns to the turbine to pass through the remainder of the stages for further extraction of energy. Higher temperatures are thus maintained in this turbine for increased efficiency.

*Energy from Exhaust Steam.* The exhaust steam from the turbine contains a useful amount of energy that normally is dissipated in the condenser. This energy is necessary to

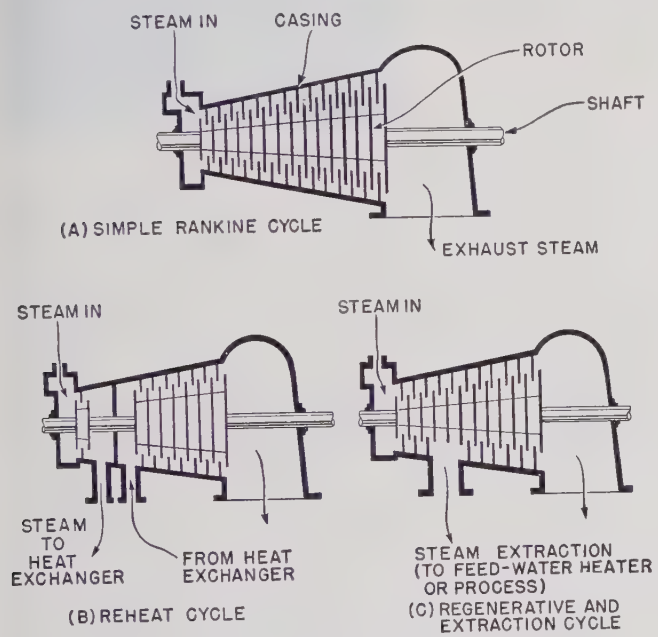



*Fig. 4—TURBINE STEAM CYCLES*

condense the steam for exhaust pressures below atmospheric and to permit rejection of the steam in the form of water. Some of this energy may be harnessed by bleeding portions of the steam at different stages of the turbine (Fig. 4*C*), then used in boiler feed-water heaters or for industrial heating. The major portion of the steam passes through the turbine. If the extracted steam is used entirely for feed-water heating, the cycle is termed regenerative. If used for other purposes the cycle is termed extraction or bleeder.

**Special Arrangements.** Since the steam volume increases on expansion, the low-pressure stages become large in diameter to accommodate the volume flowing. These diameters are limited by the maximum allowable stresses in the blading and rotor produced by the centrifugal action of rotation. In multiflow units (Fig. 5), the steam first goes through a high-pressure unit. Then it is divided to pass through two or more low-pressure units, each of which provides adequate passage for a portion of the initial steam flow. In some cases the low-pressure units are on the same shaft and in the same casing as the high-pressure unit. The arrangement may be parallel double flow, opposed double flow, or semidouble flow. If the low-pressure casings are separate from the high-pressure, the units are said to be compounded.

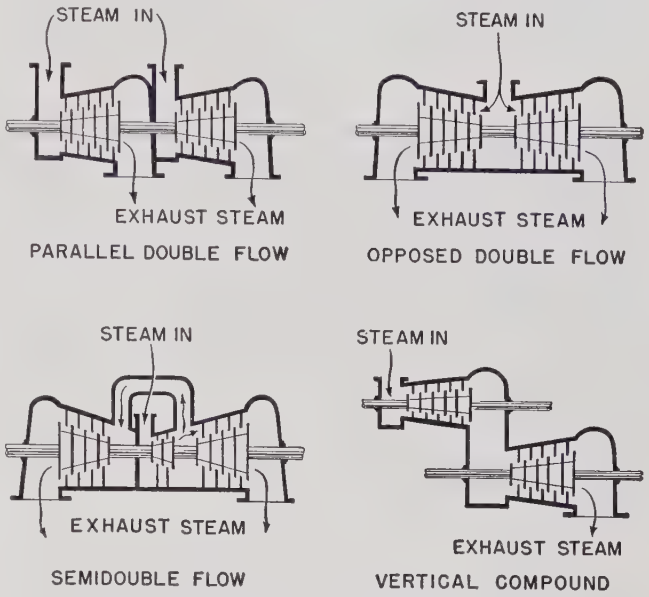



*Fig. 5—ARRANGEMENTS OF MULTIFLOW TURBINE UNITS*

A turbine that uses steam initially at high pressures, 1,200 lb. per square inch or more, is referred to as a "high-pressure turbine." This unit is specially designed and is usually segregated from the regular turbine system in some compounded arrangement. Economy and maximum load of existing low-pressure generation plants is sometimes improved by the addition of a high-pressure plant. A high-pressure turbine, or topping turbine, is installed, usually above the existing low-pressure turbine. The exhaust steam from the high-pressure turbine then feeds the low pressure turbine, together with steam from the original steam-generation system.

Back-pressure turbines exhaust the steam to a pressure higher than atmospheric, to use the heat of the exhaust in industrial processing or heating.

*Applications.* The necessary high rotative speeds of turbines for efficient operation limits their use, when coupled directly to the driven machine, to equipment that can operate at these speeds. Electric generators in central power plants, designed for speeds of 1,800 or 3,600 r.p.m., are suited to this type of drive. The turbine-generator combination is rated in terms of the electrical power output of the generator in kilowatts. Other direct-drive applications are centrifugal blowers, centrifugal pumps, fans, and centrifuges.

Slow-speed rotary equipment may be driven by the higher speed turbines through reduction gears, as in marine practice where the propellers of ships rotate at speeds from 60 to 400 r.p.m. for efficient propulsion.

## HYDRAULIC TURBINES

The hydraulic turbine is the prime mover for water-power developments. It was introduced near the beginning of the

nineteenth century as the means of producing more power from flowing water than could be obtained by water wheels, the latter being limited to a controlled change in water elevation of about the same distance as the diameter of the wheel. Modern hydraulic turbines consist of a wheel with attached buckets or blades rotating in a closed scroll or case, devices to guide the water at proper angles into and/or out of the rotating wheel, the shaft, and bearings. The shaft is connected to the power-using equipment, usually an electric generator in modern hydroelectric plants. Auxiliary devices as speed governors, water-hammer surge protectors, and trash racks are important parts of a hydraulic turbine installation.

### GAS TURBINES

A gas turbine is a machine for producing mechanical power, the principal working element of which is a bladed rotor actuated by streaming gas expanding from a higher to a lower pressure. Gas and steam turbines operate on the same principle and are similar in design. Usage also sanctions "gas turbine" to mean "gas-turbine power plant," a complete power-producing unit embodying means for combustion of fuel. *See also* AIRCRAFT PROPULSION; ELECTRIC-GENERATING POWER PLANTS; POWER PLANTS; SHIP PROPULSION; WATER POWER. H. W. I., R. G. F., and E. M. F.

**TURBOJET ENGINE.** *See* AIRCRAFT PROPULSION (*Gas Turbine Engines*).

**TURBOPROP ENGINE.** *See* AIRCRAFT PROPULSION (*Gas Turbine Engines*).

**TURBOT** [tɜ′rbət], *Rhombus maximus,* a large European flatfish of the family Bothidae, found in coastal waters from Scotland and Denmark south to the Mediterranean and Black Seas. It is characterized by a diamond-shaped, brownish-colored body, and scaleless skin covered by blunt tubercles on the left side. Like other flatfishes, the turbot has its eyes located on the left side of the head. It spawns in the spring or early summer, the females depositing about 10,000,000 eggs. A good food fish, the turbot weighs from 30 to 40 lb., but some may attain a weight of 70 lb. E. C. R.

**TURENNE. HENRI DE LA TOUR D'AUVERGNE, VICOMTE DE TURENNE** [tü′rɛ′n] (1611-1675), French military leader, was born at Sedan, Sept. 11, 1611. He served under his uncles, Maurice and Henri of Nassau, and soon distinguished himself in the French campaigns of the Thirty Years' War. Made marshal of France at the age of 32, he was, with Condé, the leading French general in the campaigns which brought the war to an end. In the wars of the Fronde, Turenne took sides against the Mazarin Regency, but reconciled himself afterward with the French Crown, and took command in the ensuing war with the Spaniards, thus becoming the adversary of Condé. He defeated Condé decisively in the Battle of the Dunes near Dunkirk in 1658. Louis XIV made him supreme commander of the French armies. In 1667 Turenne conquered a part of Flanders and Hainault in the war against Holland, and had brilliant successes in the second war against the Dutch and their allies, which began in 1672. He was especially successful against the troops of the Great Elector of Brandenburg and against the imperial troops under Montecucculi. He was killed in the Battle of Sasbach in Baden, July 27, 1675. Turenne refined his military art from campaign to campaign. In character he was both strong and gentle. Originally a Protestant, he abhorred the divisions within Christianity and in 1668, under the influence of Bossuet and his nephew the Abbé de Bouillon, was converted to the Catholic faith. W. Fr.

**TURGENEV, IVAN SERGEYEVICH** [tʊrge′nyəf] (1818-1883), Russian novelist, was born at Orel, of an old landowning family. He attended courses in philology at the universities of Moscow and St. Petersburg (1833-1838), and in 1838 went to Berlin to study philosophy. In Germany Turgenev actively participated in discussion groups of Russian students and became imbued with the ideas of Western liberalism. While still a student at the University of St. Petersburg, he began to write poetry. His first poems,

*IVAN SERGEYEVICH TURGENEV*

FROM A PAINTING BY ILYA EFIMOVICH REPIN

BROWN BROTHERS

published in 1837 in the liberal magazine *Sovreménnik* ("Contemporary"), were rather inept imitations of Byron. His long tale in verse, *Parasha* (1843), betraying a strong influence of Pushkin, was highly praised by Belinsky, the leading Russian critic of the time. However, it was in prose fiction that Turgenev scored his great successes. His first work of real distinction was *Notes of a Sportsman,* a collection of short stories, written between 1847 and 1851, but published in book form in 1852. These picturesque sketches of Russian country life, which were permeated with sympathy for the destitute peasants, were received as a plea for the abolition of serfdom. Turgenev's literary activity soon became most productive. He published a number of longer tales, such as *Asya, Correspondence, Faust, First Love,* and four full-length novels, *Rudin, A Nest of Gentlefolk, On the Eve,* and *Fathers and Sons,* that placed him among the foremost Russian writers of his time. *Rudin* (1856) portrays a Russian radical of the 1840's, a brilliant talker and a forceful propagandist, who proves, however, fatally unable to translate his resounding words into action. *A Nest of Gentlefolk* (1858) relates the tale of unhappy love and unhappy marriage, in the idyllic setting of an old-fashioned Russian manor house. *On the Eve* (1860) presents the type of a new Russian woman, energetic and brave, in quest of an ideal for purposeful social action. The figure of a strong man, significantly absent from most of Turgenev's works, appears in his best-known novel, *Fathers and Sons* (1862). The conflict between the old and the new is personified here by the dramatic showdown between Pavel Kirsanov, a genteel traditionalist, and Eugene Bazarov, a nihilist, a harsh and uncompromising champion of science and progress. Turgenev's treatment of Bazarov stirred wide controversy, in which the author was vehemently attacked by radicals and conservatives alike. His bitterness,

engendered by these partisan and often unfair criticisms, may have prompted Turgenev's decision to settle abroad. After 1863 he lived mostly in western Europe, first in Germany and then in France with the family of a celebrated Spanish singer, Pauline Garcia-Viardot. Mme. Viardot, whom Turgenev had first met in 1843, was the object of his lifelong affection. In Paris Turgenev found the French literary elite to be more appreciative of his art than most of his Russian compeers; such writers as Flaubert, the Goncourts, and Zola were among his friends and admirers. Growing alienation from Russian public opinion found its expression in *Smoke* (1867), in which the author strikes out mercilessly at reactionary Slavophiles, as well as at radical Westerners. Turgenev's last novel, *Virgin Soil* (1877), was apparently an earnest but hardly successful attempt at an objective portrayal of the rising Russian revolutionary movement. Much more satisfactory, in artistry and psychological insight, are numerous stories published during the same period, such as *Spring Torrents* (1871), *A Queer Story* (1869), and *Song of Triumphant Love* (1881). Most of these works are nostalgic reminiscences of the days gone by, and some of his late tales are slightly tinged with mysticism. He died on Sept. 3, 1883, at Bougival, near Paris; he was buried in St. Petersburg. Huge crowds of his countrymen came to the funeral to pay tribute to the great writer.

Turgenev's work lacks the epic power of Tolstoy and the searching, uncanny penetration of Dostoyevsky. He was, nevertheless, an astute observer of the human psyche and, above all, a consummate artist who managed to combine clarity and precision with emotional suggestiveness. The most romantic of all Russian realists, he had a great gift for conveying a mood, and his exquisite landscape passages, rich in lyrical undertones, heighten the evocative power of his tales.

A sincere humanitarian and liberal, Turgenev loathed tyranny and oppression. His was, however, rather a contemplative than an active nature, and more often than not he chose to keep aloof from the political battles of his time. Keenly aware though he was of current social issues, Turgenev was mainly preoccupied with psychological problems, centering around love, its ecstatic joys and bitter disappointments, and the central theme of his writings is man's quest for individual happiness and his inability to attain it.

V. E.

**TURGOT, ANNE ROBERT JACQUES, BARON DE L'AULNE** [tü'rgo'] (1727-1781), French statesman, economist, and reformer, was born in Paris on May 10, 1727. He was educated for the priesthood, later attending the Sorbonne (1749-1750). Turgot subsequently declined to take holy orders, and began his studies in economics, particularly the physiocratic system of François Quesnay and Vincent de Gournay. In 1752 he became councilor of the parliament. While on a tour of inspection of the French provinces in 1760, he began his friendship with Voltaire. Appointed to the post of intendant of Limoges (1771-1773), he applied many theories of the physiocratic school and in 1766 wrote one of his best known works, *Réflexions sur la formation et la distribution des richesses.* Turgot advocated complete freedom of commerce and industry, with taxation only on the net product of the land. Many of Turgot's ideas were adapted by Adam Smith in his *Wealth of Nations.*

In 1774 Turgot was successively minister of marine and comptroller general under Louis XVI. He made an immediate attempt to restore the tottering finances of the government by a process of rigid economy. He proceeded on the principle: "No bankruptcy, no increase of taxation, no borrowing." His policies and methods roused considerable opposition, which was brought to a head by his Six Edicts of 1776; these related (1) to the ending of forced levies of the peasantry for work on public highways, instituting instead construction for a money price; (2) declaration on the grain trade and the suppression or moderation of grain taxes; (3) the suppression of offices connected with certain ports and markets; (4) the suppression of craft guilds; (5) the suppression of the exchange of Poissy; and (6) changes in the taxes on suet (tallow). The nobility, the clergy, and the officers of the Crown were opposed to these edicts, and on May 12, 1776, the King asked for Turgot's resignation. He spent the remaining years of his life in Paris in scientific and literary studies. Turgot died there on Mar. 18, 1781.

Turgot was one of the leaders in the economic interpretation of history, much of his work having to do with permanent principles rather than with changing social forms. He has been called the founder of our present political economy, but he left no comprehensive statement of his economic theories. He foresaw the French and the Industrial revolutions and warmly advocated many doctrines of the Physiocrats, though his exact relationship to them is still a matter of controversy. The fate of Turgot and his reforms, all of which were abolished after he left office, proved that the French monarchy was then both incapable of and unwilling to reform.

T. R. H.

**TURI.** *See* Asiatic Tribes (*Indo-Iranian*).

**TURIN** or **TORINO** [tyu'rin, tyuri'n; tori'no], the capital city of the province of the same name in the region of Piedmont, northwest Italy.

**The City.** Turin lies 75 mi. southwest of Milan, on the left bank of the Po River at the confluence of the Dora Riparia, at an elevation of 775 ft. The city is situated on a rolling plain at the foot of the Alps. Across the Po to the east there is a line of hills having heights exceeding 2,000 ft.

Turin is one of Italy's leading industrial centers; in 1950 more than 200,000 workers were employed in the city's numerous factories. Much of the motive power is supplied by electricity from the near-by mountain streams. The city's principal products are automobiles, arms, machinery, clothing, textiles, chocolate, chemicals, and printed matter. Because of its industrial and commercial importance Turin was heavily bombed by the Allied air forces during World War II.

Turin came into being as the *Augusta Taurinorum,* a military colony of the Romans. During the Germanic invasions it fell under Goth, Lombard, and Frankish rule, and later the city was contested among various regional feudal lords. The Counts of Savoy asserted claims to the city which they were finally able to make good in the thirteenth century. In the sixteenth century they made Turin their capital, and in the nineteenth century the city became the intellectual and political center of the movement to free Italy from foreign domination and unite it under the House of Savoy. Pop. (off. est. 1947), 713,735.

**The Province.** The province of Turin, comprising 301 communes, has an area of 2,693 sq. mi. Small territorial changes were made along the Italo-French frontier in the Alps by the treaty of peace ratified in September 1947. The province consists partly of mountains and partly of the upper Po plain. It is entirely drained by the Po and its tributaries, and has a continental climate. The chief agricultural products are wheat, corn barley, potatoes, hay, wine, and a wide variety of fruits and vegetables. The raising of live-

stock is also important. Much of the land is irrigated. Several towns besides Turin have become industrially developed and produce machinery, vehicles, furniture, chemicals, foodstuffs, and paper. The only city in the province, aside from Turin and its suburbs, to attain a population of more than 10,000 is Pinerolo (pop. 21,600). Pop. (off. est. 1947), 1,388,000. *See also* PIEDMONT; SAVOY, HOUSE OF.

R. G. W.

**TURIN, UNIVERSITY OF,** an institution of higher learning at Turin, Italy, founded in 1404 by Louis, Duke of Savoy-Acaja. Pope Benedict XIII, the antipope of Avignon, recognized the school by papal bull in 1405, and Sigismund, Emperor of the Holy Roman Empire, issued a royal charter, in the name of the university, in 1412. In 1413 Pope John XXIII granted the young institution juridical recognition. Under Amadeus VIII, Count of Savoy, reforms were introduced in 1424 and it was reorganized in 1431. During the following four centuries its career was marked by many upsets. It was closed in 1536 when the Franco-Spanish war began. Turin was revived in 1566, and by 1571 it had acquired twenty-six chairs. When it was removed to its present palatial location in 1720 it had the faculties of theology, law, medicine, and arts. In 1729 the Botanic Garden, Maternity Institute, science laboratories, and the chair of oriental languages were established. During the French invasion in 1792 the university was closed; by 1814 it was again active. In 1855 the museum of anatomy and pathology was founded. Other institutes were successively added: astronomy (1864), general pathology and forensic medicine (1873), juridical (1882), and the science institute of Angelo Mosso (1907). The scope of instruction in 1950 included jurisprudence, economics and commerce, letters and philosophy, pedagogics, medicine and surgery, mathematics, physics and natural science, pharmacy, veterinary medicine, and agriculture. Nine faculties had a total membership of 199; student enrollment was 12,473. The library housed 181,041 volumes, 1,000 incunabula, and the Napoleonic collection of 30,000 volumes. A. L. H.-Q.

**TURK.** *See* ASIATIC TRIBES (*Ural-Altaic*).
**TURKANA.** *See* AFRICAN PEOPLES.

**TURKESTAN** [tɜ′rkɪsta′n], a vast region of central Asia stretching from the Caspian Sea, on the west, to Mongolia and central China, on the east, and from Siberia, on the north, to Tibet, India, Afghanistan, and Iran, on the south. Almost the entire territory lies today within the boundaries of the Soviet Union and China; a relatively small portion forms the northern part of Afghanistan.

Shortly before the beginning of the Christian Era most of Turkestan was inhabited by Aryans and Ural-Altaians. The Chinese began their penetration of the region about 100 B.C., and they dominated the political and cultural development of eastern Turkestan until the seventh century. The peoples of this region were largely nomadic, although in the oases and along the rivers many practiced agriculture. Gradually, as the caravan trade developed, cities arose in the southern part of Turkestan, notably Kashgar, Tashkent, and Samarkand. Meanwhile, by the end of the fifth century, a considerable part of western Turkestan had come under the rule of the Ephthalite Huns. From then until modern times the history of Turkestan has been one of almost continual struggles among rival Asiatic tribes and religious factions. For a while after the seventh century Tibet, aided by the western Turks, ruled a large part of southern Turkestan. Then, later in the eighth century, Mohammedan tribesmen swept eastward through almost the entire length of Turkestan. Three centuries later Genghis Khan and his Mongol horde invaded it from the opposite direction. Local wars between rival Moslem factions continued in much of the region until the seventeenth century, when the Chinese again pushed westward and conquered almost all of the eastern half. Although the Turks continued to resist, the Chinese province of Sinkiang was established in 1881, politically consolidating the area. Until the middle of the twentieth century, however, sporadic Moslem rebellions occurred.

Russia gradually extended its sway over western Turkestan until, in 1865, its domination was virtually complete. Under the imperial regime western Turkestan became a governor-generalship comprising several khanates. After the Revolution of 1917, these political divisions were destroyed and new ones were established on the basis of racial distribution. The main territorial units were Turkmenistan, Tadzhikistan, and Uzbekistan, although parts of Turkestan were given to Kazakhstan and Kirghizia. In 1925 a political reorganization occurred, and today western Turkestan is divided among the Turkmen, Kirghiz, Uzbek, and Tadzhik constituent republics of the Soviet Union.

That part of Turkestan lying within Afghanistan is about 500 mi. long and 100 mi. wide. It is situated along the Amu Darya. Except in the river valley, most of the territory is wasteland. Its chief city is Mazar-i-Sharif. Russia disputed Afghan control of the area until 1859. G. Q.

**TURKEY,** a republic located principally in southwestern Asia but embracing a smaller extent of territory in southeastern Europe. It has an important and strategic location, lying as it does across the Dardanelles, the Sea of Marmara, and the Bosporus, which form the only water route between the Black Sea and the Mediterranean and which separate Turkey in Asia, known as Anatolia, from Turkey in Europe, known as Eastern Thrace. Turkey in Europe is bounded on the north by Bulgaria, on the east by the Black Sea and the Bosporus, on the south by the Sea of Marmara and the Dardanelles, and on the west by Greece and the Aegean Sea. Türkey in Asia is bounded on the north by the Black Sea and the Soviet Union, on the east by the Soviet Union and Iran, on the south by Iraq, Syria, and the Mediterranean, and on the west by the Aegean Sea. The total area of Turkey is 296,190 sq. mi., of which 9,260 sq. mi. are in Europe.

## GEOGRAPHICAL FEATURES

**Topography.** Turkey is composed of the central plateau of Anatolia, which has an average altitude of from 2,500 ft. to 3,000 ft. and is bordered on the north, south, and east by mountains. The Şmali Anadolu Dağlari are on the north and the Toros Dağlari (Taurus Mountains) on the south. Eastern Turkey is dominated by the high, rugged mountains of Armenia. This eastern section, which has many lava areas, centers in Mount Ararat, with an elevation of 16,945 ft. above sea level. The surface of the large Lake Van in eastern Turkey is 5,300 ft. above sea level. Western Turkey has a fringed or drowned coast line with many rocky peninsulas and small bay-head plains, and there are a large number of offshore islands formed by drowned summits of the Şmali Anadolu and Taurus mountains. The southern or Mediterranean coast is somewhat similar, having a very narrow coastal plain backed by the spectacular Taurus Mountains. The Black Sea coastal plain is also narrow and backed by mountains, but is more regular and has fewer harbors.

**Lakes and Rivers.** Turkey has a large number of lakes, of which Tuz, in the central part, and Van, in the east, are

*A view of the Bosporus, the narrow strait which divides European from Asiatic Turkey. On the left are the palace and gardens of the sultans of the Ottoman Empire.*

the largest. Most of the rivers of Turkey are short torrential streams that flow from the coastal mountains into the sea, but several important river systems, such as those of the Sakarya and Kizil rivers, flow generally northward across the plateau and empty into the Black Sea. In the extreme east are the headwater systems of the Euphrates and Tigris rivers, flowing southeastward. Of the rivers that empty into the Mediterranean Sea, the Ceyhan system, on which the city of Adana is located, is the most important; the Büyük Menderes (the classical Meander) and Gediz are the principal rivers flowing westward into the Aegean Sea. The Kizil (the classical Halys) is the longest river in the country; half its course is saline.

**Minerals.** The bituminous coal reserves are estimated at 200-300 million tons and are quite possibly even larger. Next to the Soviet Union, Turkey is the world's largest producer of chrome ore.

The mining and manufacturing of coal, iron, and copper are a state monopoly. Several less important minerals are also produced in Turkey, among them manganese, boracite, sulphur, lead, asbestos, emery, and salt.

**Soil.** The soil of Turkey varies considerably in fertility. The soil of the interior reflects the semiarid steppe conditions of the region. Here low rainfall coupled with a sparse plant cover of short grasses has resulted in the formation of lime-accumulating steppe soils, derived from volcanic and limestone parent materials. The character of the terrain handicaps the development of deep natural soils in this highland area, and most of the soil is thin and easily eroded. Overgrazing and deforestation of the slope lands have led to an intensification of the problem of soil erosion. More productive soil is found in the coastal and lowlands regions of Turkey; here relatively flat land and more humid conditions have made for better agricultural output. The best soil is found in the alluvial valleys where newly deposited river materials are rich in minerals and organic content, but these regions are limited and isolated in extent.

**Climate.** Most of Turkey has a semiarid climate with extremes of temperature. Almost all of the Anatolian plateau has an average annual rainfall of only 20 in. or less, and has hot, dry, dusty summers, and cold, windy, damp winters. In the east, in the Armenian Knot region, the winters are long and severe, with a heavy snowfall, and the summers are short and cool. The narrow Mediterranean and Aegean coastal plains have a warm, Mediterranean climate, with short, wet winters and long, warm, sunny summers. Along the coast the January average temperature is about 50° F., and the July average about 80° F. There is about 30 in. of rainfall. The Black Sea coast is colder than the Mediterranean coast, and receives around 100 in. of rain a year.

**Flora.** Because of the variations in climate and relief, there are several different vegetation types in Turkey. Most of the Anatolian plateau is a steppe or grassland with a few dwarf trees. In the springtime, the steppe is covered with flowering plants. The Aegean and Mediterranean coasts have the usual Mediterranean flora, with pines, thorny bushes, myrtles and oleanders, scrub oaks, and palms. The Black Sea coast has a large stand of deciduous forest.

**Fauna.** Because of its position, Turkey is a meeting place for the various animal species found in Europe, Asia, and Africa. Differences between the animal varieties found in Turkey in Europe as opposed to Turkey in Asia are not too significant. The most important wild animals are the bear, boar, corsac, deer, fox, gazelle, hyena, jackal, leopard, lion, lynx, and wolf and the many varieties of rodents that frequent the steppes. Among the birds the more common are

MONSELL FROM BLACK STAR

*The interior of this 80-ft. cone of volcanic rock, a monolithic monastery in the Cappadocian mountains of central Turkey, is honeycombed with cells and passages.*

the bittern, bustard, eagle, sand grouse, partridge, pheasant, stork, and swan. Fish, both fresh-water and salt-water varieties, form an important source of food for the Turkish people. The ass, buffalo, camel, Angora goat, ox, and sheep are common. J. E. F. and A. L. R.

## ETHNOLOGY AND POPULATION

**Origin of Inhabitants.** The position of Turkey as a crossroad between Asia and Europe has allowed extensive intermingling of peoples. There is considerable doubt about the origin of the earliest inhabitants, but the available evidence indicates that physically they were very similar to the Alpine subrace of Europe, although modified subsequently by infiltrations of Gauls and Semites. In later times, when the country was subject to the Macedonian, Roman, Byzantine, and Ottoman empires, elements from the Balkans and other provinces were introduced.

*Turkish Elements.* The Turks are believed to have come to Anatolia from the region in Asia between the Ural and Altai mountains, where they had intermarried with the Mongols. The Turkish nomads, who became Moslems during their westward migration, invaded and settled Anatolia by a slow process of infiltration. They gradually spread to the surrounding coastal areas, assimilating the inhabitants in respect to both language and religion.

With the Turkish penetration into the Balkans in the middle of the fourteenth century, and especially after the fall of Constantinople in 1453, the government settled many Turks in this area in order to effect a Turkification of the native population. However, these efforts were strongly resisted by all of the Christian peoples. Even those Balkan groups—the Bosnian Slavs, Albanians, and Bulgarian Pomaks—who adopted Islam were not assimilated and Turkish influence began to decline in the nineteenth century.

*Minorities.* The modern Turkish government, with its strong emphasis upon Turkification, altered the composition of the population to a great degree. One large minority, the Armenians, had been almost completely obliterated during the last part of the nineteenth century and the early part of the twentieth century. Although the Treaty of Berlin (1878) imposed upon the sultan of Turkey the obligation to give social, economic, and political security to the Armenian people, he permitted the slaughter of hundreds of thousands in the brief period between 1894 and 1896. In the spring of 1909 several thousand Armenians were killed. In June and July 1915 systematic massacre and expulsion of Armenians were undertaken; many were driven into the Syrian Desert. In 1915 only about 100,000 Armenians remained in Turkey.

Following World War I, an exchange of population was carried out with Greece, and 400,000 Turks in Greece were sent to Turkey. This transfer, carried out by the League of Nations, was unique in the history of the world. The largest minority in modern Turkey are the Kurds, a nomadic people who live in the eastern part of Turkey and also in contiguous parts of Iran and Iraq (a region sometimes collectively called Kurdistan). Accustomed to almost complete independence, the Kurds resisted the growing strength of the Turkish Republic, which antagonized them by abrogating Moslem laws and customs. They revolted in 1925, but the rebellion was quickly and ruthlessly crushed, and, since then, their tribal autonomy has disappeared. A special regime was set up in Kurdish vilayets after the rebellion, and it was not until December 1946 that they were given the same status as other vilayets in Turkey. Although many Turkish leaders consider the Kurdish question as having been solved, the problem of Kurdish nationalism has not been eliminated. The proximity of these Kurds to the border of the Soviet Union adds to the significance of their nationalism.

The largest Turkish minorities outside Turkey are those of Bulgaria (500,000), Romania (200,000), Yugoslavia (150,000), and Greece (80,000). Bulgaria has expelled many thousands of Turks, who sought asylum in Turkey. During the 1930's Turkey absorbed annually between 10,000 and 30,000 Turkish émigrés from the Balkan states. In Turkey itself the Turks form about 84 per cent of the population; the Kurds, 10 per cent; Greeks, 2 per cent; Bulgarians, 1.5 per cent; and Yugoslavs, 1 per cent.

**Language.** Osmanli, or Ottoman Turkish, belongs to the Altaic family of languages, spoken in most of central and northern Asia, and is related to the Magyar and Finnish languages. It was written in Arabic script until 1926, when the Roman alphabet was substituted in official correspondence; in 1928 the Roman alphabet was adopted for universal use. The official name of the language is no longer Osmanli, but *türk dili,* the Turkish language.

**Religion.** Although Islam was abolished as the state religion in 1928, 98 per cent of the people are still Moslems. Turkish has been substituted for Arabic as the liturgical language in all mosques, and the present law forbids the wearing of clerical garb except in places of worship and during divine services.

İstanbul is the seat of the Ecumenical Patriarch, who is the head of the Orthodox Church in Turkey. The Armenian Church (Gregorian) is ruled by a Patriarch in İstanbul; the

Uniat Armenian Church by the Patriarch of Cilicia; the Chaldaeans by a Bishop of Mardin; the Latins by an Apostolic Delegate in İstanbul and the Archbishop of İzmir; and for the Jews there is a Grand Rabbi in İstanbul.

**Population.** The census of 1950 placed the population at 20,934,670. The average annual rate of increase for the population is 23 per thousand, one of the highest in the world, and it is reported that the average number of children per family is six. In 1950, 1,626,229 inhabitants lived in European Turkey and 19,308,441 in Anatolia.

The northern and western vilayets and the coastal areas are the most densely populated, whereas the central plateau is very sparsely populated. There are also large nomadic tribes, especially the Kurds. The average density is 64 per sq. mi., one of the lowest in the world. The most densely populated provinces are İstanbul (199), Trabzon (152), and Hatay (120). According to the 1950 census the major cities were: Istanbul, 1,000,022; Ankara, 286,781; Izmir (Smyrna), 230,508; Adana, 117,799; and Bursa, 100,007.

## GOVERNMENT AND POLITICS

**Structure of Government.** The Constitution of 1924, which was drawn up by Kemal Atatürk, declares that Turkey is a republic with a president as the head of the state. The sovereignty lies with the people, and the supreme legislative authority is vested in a single chamber, known as the Grand National Assembly, which is elected by universal suffrage. The deputies, who are elected for terms of four years, elect the president of the republic and the chairman of the parliament. The president chooses the prime minister, is supreme commander of the armed forces, and is charged with putting into effect, within ten days, the laws passed by the parliament. He may return a bill to the Assembly for reconsideration, but must sign it if the parliament reaffirms its decision. Secret ballot and open-count are assured for all elections.

The Assembly meets annually at a fixed date and remains in session for at least six months. Its functions are to make and amend, abrogate and interpret laws, to conclude treaties with foreign countries, declare war, approve the state budget, safeguard the legal tender, and decree amnesties. It is also responsible for all financial matters and for judicial investigations. There is one deputy for every 40,000 people. (For the elections of 1954 there were 541 seats.) Although the constitution vests executive and legislative power in the Assembly, that body formally delegates executive power to the cabinet, and it is exercised directly by the president, who thus, in practice, has absolute powers. The 1924 constitution guarantees the courts of law full independence.

**Political Movements.** The Republican People's Party, which was founded by Kemal Atatürk, had no genuine opposition until the appearance in the summer of 1945 of the Democratic Party under the leadership of the former Premier Celâl Bayar. Formation of this party was not a result of its leaders' disagreement with the aims of the Kemalist revolution but of dissatisfaction with the manner in which the Republican People's Party was carrying out these aims. In general, the Democratic Party has worked for liberal reforms within the Kemalist framework. The Republican People's Party stands for the differentiation of Turkish society along professional rather than class lines, for a substantial although not exclusive participation of the state in the economic life of the nation, for the encouragement of credit and consumers' co-operatives, for the prohibition of strikes and lockouts, for a stringent state control over trusts and cartels, and for secular education. However, in the course of its authoritarian rule this party promulgated a series of laws which are regarded as denying many privileges and rights guaranteed by the Constitution of 1924.

However, opposition parties have come to the fore, and in the first free election, in May 1950, Celâl Bayar, leader of the Democratic Party, was elected president of Turkey, succeeding General İsmet İnonu, who had served since 1938. On Feb. 20, 1952, the Peasant Party was formed; there are 18 other splinter parties.

**Local Government.** Turkey is divided into 63 İl (vilayets), which are subdivided into İlçe, and these in turn are divided into bucak. A vali, representing the government, is at the head of each of the vilayets.

**Finances.** Although Turkey has received loans from the United States, Great Britain, and France, it has also stabilized its economy since World War II. From the United States it has received grants for military and reconstruction purposes, and from the International Bank it has obtained a loan of about $25,000,000 for the construction of the Seyhan River Dam. In 1944 Turkey paid its last installment on the war debt set by the Treaty of Lausanne. A law of 1951 guaranteed foreign investment and industries that promised to develop Turkish economy, and in 1954 another law denationalized Turkey's oil reserves, so that foreign companies could negotiate contracts on the basis of a 50 per cent share of the profits. In 1955 the lira was valued at 35 cents.

**International Relations.** Before World War II, Turkey maintained very friendly relations with Yugoslavia, Romania, and Greece, and with them had concluded the Balkan Pact in 1934. Relations with Bulgaria were periodically tense, although an agreement in 1925 for the emigration of Turks from Bulgaria was signed and for the most part adhered to. The friendly relations established by Lenin and Kemal continued through most of the interwar period, not beginning to deteriorate until after the conclusion of the Nazi-Soviet pact in 1939. Relations with the Arab countries were cool because of Arab resentment of the Kemalist program, which was regarded as inimical to the traditional institutions of Islam. After the Italian plunge into Ethiopia in 1935, Turkey gradually turned to Great Britain and France, and in the next few years concluded various agreements with them, signing the formal treaty of mutual assistance in October 1939. After World War II there was some improvement in relations with the Arab countries. Turkey was among the first states to recognize the independence of Syria and Lebanon. However, the Syrians have not reconciled themselves to the loss of the Sanjak Alexandretta (Hatay), which France surrendered to Turkey in 1939. Turkey was an original member of the United Nations, and in 1951 was elected to the Security Council. In 1954 Turkey signed a security pact with Pakistan, which was later extended to include Iraq and Iran. Turkish representatives attended the Rome and Ottawa conferences of the North Atlantic Treaty Organization (NATO), which it entered on Feb. 18, 1952, despite the warnings and protests of the Soviet Union. In the summer of 1952 discussions were held with the Yugoslav and Greek governments, and in May 1953 the Assembly ratified a treaty of friendship and cooperation among the three countries. On Aug. 9, 1954, Yugoslavia, Greece, and Turkey signed a military alliance; but relationships between the Greek and Turkish governments were marred by opposing positions taken concerning the status of the British-held island of Cyprus, whose Greek majority agitated for union with Greece, while a Turkish minority supported the British.

**Defense.** Following World War II Turkey's armed

forces were extensively reorganized. Compulsory service in the army, navy, or air force was for a period of three years. The strength of the Turkish forces in 1955 was about 850,000, and the total number that could be mobilized in time of emergency was estimated at over 2,000,000. Since 1947 the Turkish armed forces have been in the process of intensive modernization, and in the Korean War they gave a very good account of themselves. The navy and air force have been expanded, although still considered secondary in relation to the excellent ground forces. American technical and material assistance has done much to improve the Turkish armed forces. There is a modern naval base at Galcuk on the Gulf of Smyrna.

## ECONOMIC RESOURCES AND ACTIVITIES

**Agriculture.** Turkey has all the requisites for a flourishing agrarian economy. About four fifths of the population is rural. However, the country is sparsely populated and only about 20 per cent of the land is cultivated annually. The Anatolian plateau is suitable for grazing purposes and supports extensive livestock. Agriculture is the most vital element in the country's economic life, though before the advent of the republic the country was backward in development of this field. The soil in most areas of Turkey is not very productive, and most of the peasants are extremely poor; more than half of the peasants owned no land in 1937, although from 1930 to 1937, 320,000 acres of land were distributed, mainly to those who returned from various Balkan countries to take up residence again in Turkey.

Grain production has increased to the point where Turkey is exporting it. In addition to cereals, mostly barley, important products are tobacco, figs, olives, opium, silk cocoons, and cotton. Turkey produces wool and woolen goods. Bursa, near İstanbul, is famous for production of silk. Credit facilities are extended to farmers by the Agricultural Bank and by the credit co-operatives organized by the bank. In 1949 there were nearly 600 such co-operatives, with a membership of 270,000. The Agricultural and Veterinary institutes contributed much toward improving methods of cultivation and breeding. In 1937 a 12-year irrigation project was begun, and in 1947 over 150,000 acres were being irrigated.

BLACK STAR

*Craftsmen of Eskişehir, Turkey, processing lumps of meerschaum. This soft stone is taken from deposits 40 ft. underground and cleaned, carved, and polished in the shops of numerous exporters.*

Various amelioration and reclamation projects were initiated. In 1945 the Land Reform Bill was enacted, aimed at transforming Turkey into a nation of small landholders. The bill provided for distribution among landless peasantry of state and vakif (ecclesiastical) land, as well as privately owned land in excess of 4.5 sq. km. One third of the rural population was expected to benefit from the Land Reform Bill. Expropriated lands were to be compensated. By 1952, however, much remained to be accomplished, in spite of the important progress actually achieved.

**Lumbering.** Approximately 10 per cent of the total area of the country is covered with forests. The government has begun an intensive exploitation of old forests to meet the country's demand for lumber. In the 1920's Turkey imported lumber; in the 1930's it began to export it, mostly to Syria and Greece.

**Industry.** Industrialization has been one of the chief aims of the Turkish Republic. From 1923 to 1933 private capital was encouraged by special privileges to carry through the development of industry. However, the response was not sufficient, and in 1933 the government began a policy of state industrialization. The first Five-Year Industrialization Plan (1934) was designed to establish the basic steel, copper, and chemical industries, to exploit the country's mineral resources, and to increase the production of consumers' goods such as textiles, porcelain, and paper. The greatest advance under this plan was made by the textile industry, the number of spindles having increased from 94,000 in 1932 to 237,000 in 1937. A new plan was adopted to build ports at Zonguldak and Trabzon, to increase mineral production, and to build a merchant marine. The two paper mills at İzmir (Smyrna) produce paper to meet a part of the domestic need. The steel works at Karabük, built by British engineers, supply some of Turkey's needed steel. In 1937 a Three-Year Industrialization Plan and in 1938 a Four-Year Industrialization Plan were set up. This planning had to be postponed because of World War II, but industrialization was not stopped altogether and Turkey in a short time developed quite a number of industries, whose output nearly doubled between 1936 and 1947. In 1949 the state controlled 75 per cent of the country's manufacture. Most of the smaller enterprises, however, remained in private hands, and since 1951 shipping has been returned to private ownership. A Ten-Year Plan for coal and lignite, a Five-Year Plan for steel and iron, as well as other plans, were produced during and after the war. However, Turkey remains dependent on imports of industrial goods. The principal industrial products are cement, cotton, and woolen yarns, textiles, rugs, carpets, paper, glass, and ceramics.

**Commerce.** Due to its efforts at industrialization, Turkey imports great amounts of machinery, iron, and steel, in addition to petroleum products and woolens, and thus has an adverse trade balance. This balance had dropped, however, to $20,000,000 by 1954. Turkey's imports come primarily from the United States, Great Britain, Italy, Germany, and France. Its leading exports are tobacco, cotton, filberts, cereals, raisins, and fruit, and they go mainly to the United States, Great Britain, Italy, Egypt, Belgium, and Switzerland. Turkey is the leading exporter of olive oil and has a monopoly on meerschaum.

**Banking.** The principal banking establishment is the Central Bank (Merkez Bank), which issues notes and controls exchange operations. The Sümer Bank is in charge of nationalized industries (cotton, wood, steel). The Eti Bank manages mineral production. The Agricultural Bank handles agricultural work.

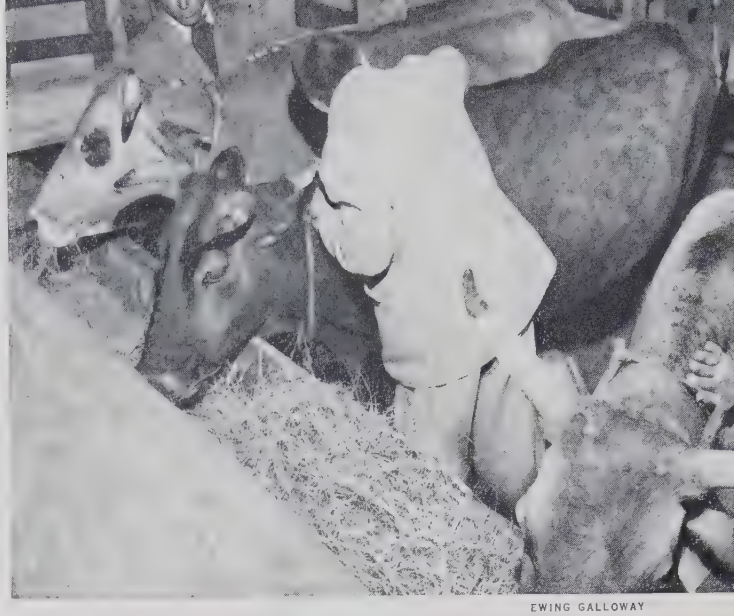
**Transportation.** Good highways in Turkey have reached the 30,000-mile mark; most of these roads have been constructed since 1948, through a contract between the Ministry of Public Works and the United States mission set up for that purpose. Railroad mileage has reached 5,000, all state-owned. Railroads linking the Turkish to the Iranian and Iraqi systems are under construction, as are railways to the ports of Mudanya and Antalya, and a new trunk line across Anatolia from east to west is planned. The state airline was founded in 1933.

**Labor Conditions.** An effort is being made to train technicians and engineers in order to improve the quality of the working force. The Labor Code adopted in 1936 prohibits strikes or lockouts. It is estimated that 850,000 men, nearly 5 per cent of the population, are under arms, and this is a serious impediment to production in a country with an ever-present labor shortage. The Ministry of Labor was created in June 1945. In January 1947 a Labor Council, representing employers, employees, and the government, was organized. In the spring of 1947 a bill was passed allowing the formation of employees' associations and labor unions. As the country is predominantly agrarian and factories are for the most part state owned, the labor movement has not acquired great importance.

## SOCIAL AND CULTURAL ACTIVITIES

**Reforms.** The greatest achievement of the republican regime in Turkey is in the field of cultural and social reforms. Through these reforms, Turkey has been regenerated to such an extent that there is little similarity between the modern nation and that of the period before World War I. The educational program is based on the principles that education should conform with the interests of the republic; that the school room should be closed to any religious influence; that education should be democratic, i.e., that every child, regardless of social status, should have equal access to educational facilities; that the school should be state supported and state managed; and, finally, that the schools should be co-educational. Among other important reforms promulgated by the republican regime are: abolition of the fez and turban for men and the veil for women; abolition of the salaam and old forms of greeting; substitution of the Roman alphabet for the Arabic script; giving women the right to vote and equality with men; abolition of polygamy; adoption of the European calendar; abolition of the Shari'a law and adoption of the Swiss civil code and the Italian penal code; and modification of the German commercial code. In general, all that belonged to the old empire has been swept away in favor of Western ideas and practices.

**Education.** Great progress has been made in education under republican rule. The schools are mostly co-educational. Most schools are state owned. The so-called village institutes, which admit graduates of the village primary schools and teach them in an atmosphere of village life, have been established throughout the country. A higher village institute has been opened at Hasanoglan, near Ankara. Turkey has about 17,500 primary and 500 secondary schools, with about 42,000 teachers and not quite 2,000,000 pupils; about 100 lycées, with about 2,000 teachers and some 30,000 pupils; about a dozen normal schools and two dozen village institutes; over 300 professional schools, with about 4,000 teachers and 40,000 students; and 33 institutions of higher learning, with some 2,000 teachers and more than 25,000 students. The last category includes four schools of university level: the University of İstanbul, the Technical University of İstanbul, the School of Political Sciences, and the University of Ankara. Other important schools are the Institute of Education of İstanbul, the Gazi Institute of Education of Ankara, and a similar school in Balikesir. The American schools, Robert College and American College for Girls, both in İstanbul, play an important role in educating young Turks. Adult education is carried out by the *Halkevleri,* the People's Houses, run by the Republican People's Party. Among other institutions are the Academy of Fine Arts, the Economic-Commercial School, the Maritime Commercial School, and the Engineering School, all in İstanbul. Illiteracy was still about 70 per cent in 1955, but prevailed chiefly among adults; the younger generation is almost entirely literate.



EWING GALLOWAY

*Turkish schoolboys gaining practical experience in animal husbandry at the Hasanoglan Village Institute near Ankara*

**Cultural Development.** One of the results of reforms under the republican regime in Turkey has been the liberalization of cultural outlook. The visual arts were severely handicapped during the empire, since the Mohammedan religion forbade the portrayal of the human figure or even animals. They have developed at a slow pace since the republic was established. The Ottoman Empire gained fame for its handicrafts, particularly carpets, jewelry, and metalwork. Ottoman architecture was highly developed.

**Historical Monuments.** The Turkish government places great emphasis upon the past glories of Anatolia, and almost every small town has a museum for which its director is charged with gathering everything of importance. The

*Tobacco leaves being cured by the sun at Samsun, a tobacco-raising center and port on the Black Sea*

EWING GALLOWAY

Ankara Archaeological Museum is the central museum of Turkey and has a fine collection of prehistoric and Hittite antiquities. The Museum of Turkish and Islamic Art in İstanbul has an extensive collection of Turkish rugs and manuscripts. Also in İstanbul is the Hagia Sophia Museum in the Byzantine basilica, built by Justinian in 537. This museum has a collection of Byzantine and Ottoman antiquities. Archaeology is greatly encouraged by the Turkish Republic, and many important remains have been discovered.

## HISTORY

**Early Ottoman Empire.** In the beginning of the seventh century the Turks had expanded over the steppes of Central Asia, ruling an empire extending from Mongolia to the Black Sea. There is much that remains uncertain regarding their racial origin and their relationship with such peoples as the Huns and Avars. A nomadic people, they spoke a language in many ways akin to Mongol, and they came to adopt Islam. Between the ninth and the eleventh centuries the Turks expanded into present-day Iraq and into Syria and Asia Minor, some of them going farther east. The Abbasid Caliphate of Baghdad became a mere enclave of Turkish power. The Seljuk Turks, taking their name from their leader, pressed against the Byzantine Empire, and in 1071 at Manzikert, in the mountains of Armenia, they won a crushing victory over the Byzantine forces. The Turks were led by Alp Arslan, great-grandson of Seljuk, and chose to remain in Asia Minor, where they established the Sultanate of Rum. The Sultanate disintegrated toward the end of the eleventh century into a number of rival emirates, military organizations deriving their livelihood chiefly from booty. These emirates were so disunited that they were unable to take advantage of the situation in the Byzantine Empire in 1204 when the Christian forces of the Fourth Crusade captured and sacked Constantinople.

The Seljuks had to fight for their very existence during the middle of the thirteenth century when the hordes of the Mongol Genghis Khan flooded Anatolia. They were saved only by the sudden collapse of the ephemeral Mongol Empire. A Turkish chieftain, Ertogrul, had particularly distinguished himself in the battles with the Mongols. Meanwhile, the emirate of his son, Osman (1299-1326), had emerged as the most powerful, becoming the nucleus around which the Ottoman Empire developed. As a result of Osman's popularity, his followers took the name Osmanli, hence Othman, or Ottoman, the followers of Osman. He was the founder of the Osman Dynasty, which ruled the Ottoman Empire until 1923, when, after the abdication of Mohammed VI (1918-1922), the thirty-ninth of this dynasty, the Turkish Republic was founded. Whether the Osmanli Turks were a fresh Turkish tribe from Central Asia or descendants of the Seljuks remains controversial. In 1326 Osman's forces captured Brusa, where Orkhan (1326-1359), his son and successor, set up the seat of the empire. Orkhan's greatest single accomplishment was the development of a strong and well-organized force, dividing it into feudal and standing branches. Nicaea and Nicomedia, the important Byzantine commercial centers, were captured in 1329 and 1338, respectively, and in 1354 Orkhan had established a foothold on the Dardanelles, paving the way for the Turkish penetration of the Balkans.

Orkhan was succeeded by Murad I (1359-1389), who conquered Thrace and transferred the Ottoman capital to Adrianople. Having occupied parts of Bulgaria and Macedonia, Murad crushed the Serbs on the Maritsa River in 1371, and at the battle of Kosovo Polje in 1389, where he and the Serbian leader, Lazar, lost their lives in the bloody battle. Murad had devised a policy of incorporation and assimilation of the Christians into the Ottoman society through the famous *devchurme,* by which certain numbers of Christian boys were delivered at designated periods to the Ottoman authorities and converted to Islam. They were tutored as civil and military leaders, and filled the ranks of the standing infantry, the so-called Janizaries (Turkish *Yenicheri*). The Janizaries were the personal slaves of the sultan, his bodyguard, and at the beginning they were not permitted to marry. Originally, their number was limited to 20,000, but this was increased rapidly, and during the reign of Suleiman the Magnificent the Janizaries gained the right to marry. Their power became so great that they enthroned and dethroned sultans at will and instigated revolutions. In this way by enlisting Christians into the service of the Ottoman Empire the Turks were able to assure the permanent domination of a handful of Moslem invaders over a vast non-Moslem population.

Murad was succeeded by Bajazet I (1389-1403), who defeated King Sigismund of Hungary at Nicopolis in 1396 and then conquered Asia Minor. Just as it appeared that the Ottoman Empire had become a reality, a great catastrophe befell Bajazet. A Mongolian raider, Timur the Lame, or Tamerlane, destroyed the army of Bajazet at Angora in 1402 and took Bajazet prisoner. The conquered peoples were too weak to throw off the Turkish rule and the Ottoman state survived, despite the civil war among the sons of Bajazet. Meanwhile, Tamerlane withdrew from Anatolia.

Mohammed I (1413-1421), known as "the Gentleman," was a man devoted to learning but he was not a political and military leader. It was Murad II (1421-1451) who completed the subjection of the Balkan peoples. He fought with the Byzantine Empire, the Serbs, Albania, Walachia, Hungary, and even the emirs of Asia Minor. In 1430, he captured Thessaloníki (Salonika), and then subjected to his rule the Greek princes in Morea. However, in 1443, after repeated defeat by the Hungarian János Hunyadi, Murad was forced to make peace with the Hungarians. The war reopened in 1444 and Murad defeated the Hungarians at Varna.

Mohammed II (1451-1481), with an army of 150,000 men and one hundred ships, captured Constantinople on May 29, 1453, overthrowing the last bit of the Byzantine Empire and the last Roman emperor, Constantine XI Palaeologus. By the capture of Constantinople, the Turks came under the direct and very effective influence of the Byzantine tradition. From this point an amalgamated Byzantine-Turkish civilization was carried to almost every corner of the Balkans. The Turks accepted the principles of state organization as crystallized by the Byzantine emperors.

**Zenith of Empire.** By the beginning of the fifteenth century the Ottomans had captured the last of Bulgaria and by the sixteenth century they had taken the last remnants of Serbia, dispersed the petty Greek rulers and captured Bosnia, Albania, and Hercegovina. They also had defeated Venice during a six-year war from 1463 to 1469, subjugated Moldavia in 1512, crushed the Magyars in 1526, and besieged Vienna in 1529. Bajazet II (1481-1512) on the whole pursued a peaceful policy and for this reason was overthrown by the Janizaries. Selim I (1512-1520), called "the Savage," destroyed the reborn emirates in Asia Minor, defeated the Persians in 1516, and the Mamelukes of Egypt in 1517. In Egypt he found the last Abbasid Caliph, who, under circumstances not too clear, transferred the Caliphate to the Ottoman Sultan. From this time until 1922 the Ottoman sultan was also caliph, or religious head, of all Moslems. The conquests of Selim led to problems of administration and to the growth of militarism and Moslem religious fanaticism.

# TURKEY

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## TURKEY

Area..... 296,190 sq. m.
Population....20,934,670

KEY TO MAP SYMBOLS

- ⊛ National Capital
- ● Size of symbols and type indicates relative population.

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Denizli, 22,029.....D 7
Derik, 3,842.....D13
Divriği, 6,271.....C12
Diyarbakir, 45,495.....D13
Doğubayazit, 2,849....C15
Dortyol, 5,720.....D11
Düzce, 10,153.....B 8
Edirne, 30,245.....B 6
Eğridir, 5,766.....D 8
Elâziğ, 29,044.....C12
Elbistan, 7,477.....C11
Emirdağ, 6,224.....C 8
Enez, 566.....B 6
Erciş, 5,536.....C14
Ereğli, 18,480.....D10
Ereğli, 6,965.....B 8
Ermenek, 6,930.....D 6
Erzincan, 18,233.....C12
Erzurum, 54,360.....C13
Eskişehir, 88,459.....C 8
Ezine, 3,813.....C 6
Fatsa, 5,024.....B11
Fethiye, 4,364.....D 7
Finike, 1,382.....D 8
Gaziantep, 72,743.....D11
Gediz, 5,976.....C 7
Gelibolu (Gallipoli), 9,911.....B 6
Gemlik, 8,509.....B 7
Gercüş, 2,411.....D13
Gerede, 4,145.....B 9
Gerze, 4,323.....B10

LETTERS AND FIGURES IN RIGHT HAND COLUMN OF INDEX ARE THE LOCATION KEYS. THE CORRESPONDING LETTERS AND FIGURES APPEAR IN THE MAP BORDER BETWEEN LATITUDE AND LONGITUDE LINES WHICH FORM THE REFERENCE ZONES.

# TURKEY

Black Sea
SOVIET UNION
TURKEY
IRAN
IRAQ
SYRIA
LEBANON
ISRAEL
JORDAN
SAUDI ARABIA
Red Sea
Gulf of Aqaba
Gulf of Suez
SINAI PENINSULA
Gudauty
Sukhumi
Kvezani
Zugdidi
Tsulukidze
Stalinir
Khunzakh
Ochemchiri
Anaklıya
Mikha Tskhakaya
Kutaisi
Belokany
Potı
Kobuleti
Batumi
Akhaltsikhe
Surami
Borzhomi
Gori
Telavi
Tbilisi
Signakhi
Zakataly
Lyuksemburgi
Hopa
Artvin
Ardahan
Kirovakan
Kirovabad
Leninakan
Nor Bayazet
Sevan
Yerevan
Basargechar
Kamarlyu
Iğdır
Goris
Nakhichevan
Dzhulfa
Maku
Doğubayazıt
Ararat
Kars
Oltu
İspir
Sarıkamış
Kağızman
Rize
Trabzon
Akçaabat (Polathane)
Vakfikebir (Büyükliman)
Ordu
Giresun
Tirebolu
Gümüşane
Bayburt
Şebinkarahisar
Reşadiye
Zile
Tokat
Erzincan
Tercan
Erzurum
Karaköse
Sivas
Zara
Divriği
Kığı
Hınıs
Malazgirt
Erciş
Nasik
Khoi
Urmia
Dazgirt
Marand
Shahpur (Dilman)
Van
L. Van
Bitlis
Muş
Tatvan
Lice
Elâzığ
Malatya
Pütürge
Darende
Akçadağ
Adıyaman
Diyarbakır
Kurtalan
Siirt
Hakâri
Cizre
Gercuş
Midyat
Nusaybin
Mardin
Derik
Savur
Siverek
Bingöl (Çapakçur)
Arapkir
Çemişkezek
Mazgirt
Pertek
Kâzım Paşa (Saray)
Süphan
Kirşehir
Avanos
Kayseri
Pınarbaşı
İncesu
Nevşehir
Aksaray
Niğde
Konya
Karapınar
Ereğli
Karaisalı
Kozan
Adana
Tarsus
Mersin
Osmaniye
Gaziantep
Kilis
Birecik
Sürüç
Urfa
Ras el 'Ain
Kamichli
Djerablous
Tel Abiad
El Haseke
Aleppo
Meskéné
Raqqa
Antakya (Antioch)
Süveydiye
Idlib
Jisr esh Shughur
Alexandretta (Iskenderun)
Gulf of Alexandretta
Latakia
Rizokarpaso
Famagusta
Nicosia
Ayia Napa
Polis
Limassol
Larnaca
Tripoli
Batroun
Hermel
El Qaryatein
Baalbek
En Nebk
Zahle
Zebdani
Rachaya
Beirut (Beyrouth)
Saida
Tyre
Damascus
Merdjayoun (Damas)
El Quneitra
Tiberias
Acre
Haifa
Nazareth
Semakh
Safad
Fiq
Chahba
Es Suweida
Der'a
Irbid
Busra
Hadera
Herzliya
Tel Aviv
Jaffa
Nablus
Jerusalem
Bethlehem
Hebron
Gaza
Khan Yunis
Rafah
Beersheba
Arish
Port Said
Port Fouad
Romana
Qantara
Suez
Ismailia
Canal
El Shatt
Port Taufiq
Nekhl
Themed
Aqaba
Dhahab
Nuweiba
Haqal
Tor
Nebk
Maqna
Tebuk
Mahtab
Dhat al Hajj
Qal'at el Mudauwara
Wadi er Retem
Jebel Ram
Naqb Ashtar
Hausa (Oasis)
Sakaka
Al Jauf
Dhaba
Al Muwaillih
Qal'at el Muadhdham
Taima
Dar al Hamra
Al Ageila
Taba
Faid
Kahafa
Al Qusaiba
Jubba
Twaiyya
Hail
Jadhamiyah
Turaba
Al Qulaiyaba (Oasis)
Al Haiyaniya (Oasis)
Lina
Artaiyan (Oasis)
Khabrat Juraiba (Oasis)
Umm el Asifir
Jumaima
Al Hafir (Oasis)
Bir Fajr (Oasis)
Mugur an Na'am (Oasis)
Judaidat al Arar (Oasis)
Ash Shabicha
Maniya (Oasis)
As Salman
Al Khart
Lafiya (Oasis)
Shaib al Qur
Shaib Hub
Ar'ar
Rutba
Ghadir as Sufi (Oasis)
Bir Sejri (Oasis)
Ramadi
Hit
Al Kadhimain
Baghdad
Ba'quba
Khanaqin
Samarra
Haditha
Abou Kémal
Ana
Deir-ez-Zor
Meyadin
Tikrit
Kifri
Tuz Khurmatli
Kirkuk
Sulaimaniya
Erbil
Altun Köprü
Mosul
Tall 'Afar
Badi
Qal'a Sharqat
Ruwandiz
Manahbad (Saujbulagh)
(PERSIA)
Dizful
Shahpur (Dilman)
Rizaiyeh (Urmia)
Lake Urmia
Great Zab
Little Zab
Euphrates
Tigris
Nahr Khabour
Wadi Hauran
Ajlun
Irbid
Mafraq
Es Salt
Amman
Qasr al Kharana
Dhiban
El Qatrani
Kerak
Tafila
Jurf ed Durawish
Ma'an
Hausa
Dead Sea
Jordan
Palestine
Syrian Desert
Hadhaudha
Great Nafud
Dahna
Ad Diwaniya
An Najaf
Al Ubaiyidh
Hilla
Karbala
Lake Razazah
Lake Habbaniyah
Lake Tharthar
Lake Milh
Lake Hammar
Lake Sawa
Lake Urmia
Lake Van
Lake Tuz
Lake Burullus
Lake Manzala
Lake Timsah
Lake Bardawil
Lake Qarun
Lake Nasser
Lake Nubia
Lake Nuweiba
Lake Aswan
Lake Edku
Lake Idku
Lake Maryut
Lake Mareotis
Lake Abu Dir
Lake Abu Qir
Lake Borullus
Lake Menzaleh

## TURKEY *Continued*


Seydişehir, 4,523 . . . . . D 8
Siirt, 15,574 . . . . . D13
Sile, 2,012 . . . . . B 7
Silifke, 6,303 . . . . . D 9
Silivri, 4,182 . . . . . B 7
Simav, 5,415 . . . . . C 7
Sindirgi, 3,605 . . . . . C 7
Sinop, 5,780 . . . . . A10
Sivas, 52,269 . . . . . C11
Siverek, 18,992 . . . . . D12
Sivrihisar, 6,638 . . . . . C 8
Sungurlu, 6,461 . . . . . B10
Sürüç, 4,217 . . . . . D12
Susurluk, 6,752 . . . . . C 7
Süveydiye . . . . . D10
Tarsus, 33,822 . . . . . D10
Taşköprü, 4,601 . . . . . B10
Tatvan, 3,179 . . . . . C14
Tekirdağ, 15,680 . . . . . B 6
Tercan, 1,720 . . . . . C13
Tire, 22,177 . . . . . C 6
Tirebolu, 4,246 . . . . . B12
Tokat, 21,700 . . . . . B11
Tosya, 11,591 . . . . . B10
Trabzon, 33,969 . . . . . B12
Turgutlu, 25,139 . . . . . C 6
Uluborlu, 4,276 . . . . . C 8
Ulukisla, 3,664 . . . . . D10
Ünye, 8,532 . . . . . B11
Urfa, 37,456 . . . . . D12
Uşak, 19,946 . . . . . C 7
Üsküdar, 69,671 (part of İstanoul) . . . . . B 7
Uzunköprü, 12,059 . . . . . B 6
Vakfikebir (Büyükliman), 1,394 . . . . . B12
Van, 13,471 . . . . . C14
Vezirköprü, 6,266 . . . . . B10
Vize, 4,891 . . . . . B 6
Yalova, 3,897 . . . . . B 7
Yalvaç, 8,199 . . . . . C 8
Yozgat, 12,032 . . . . . C10
Zara, 6,717 C11
Zile, 17,121 . . . . . B10
Zonguldak, 35,631 . . . . . B 8


### POLITICAL DIVISIONS

Not shown on map. Index key denotes approximate location.

AFYON KARAHISAR . . . C 8
Area . . . . . 5,234 sq. m.
Pop . . . . . 372,566

AGRI . . . . . C 14
Area . . . . . 4,888 sq. m.
Pop . . . . . 155,545

AMASYA . . . . . B 10
Area . . . . . 1,886 sq. m.
Pop . . . . . 163,494

ANKARA . . . . . C 9
Area . . . . . 11,442 sq. m.
Pop . . . . . 818,271

ANTALYA . . . . . D 8
Area . . . . . 7,771 sq. m.
Pop . . . . . 312,102

AYDIN . . . . . D 7
Area . . . . . 2,952 sq. m.
Pop . . . . . 337,979

BALIKESİR . . . . . C 6
Area . . . . . 5,982 sq. m.
Pop . . . . . 563,100

BİLECİK . . . . . B 8
Area . . . . . 2,030 sq. m.
Pop . . . . . 136,844

BİNGÖL . . . . . C 13
Area . . . . . 3,307 sq. m.
Pop . . . . . 97,225

BİTLİS . . . . . C 14
Area . . . . . 2,679 sq. m.
Pop . . . . . 88,422

BOLU . . . . . B 8
Area . . . . . 4,433 sq. m.
Pop . . . . . 302,805

BURDUR . . . . . D 8
Area . . . . . 2,876 sq. m.
Pop . . . . . 136,359

BURSA . . . . . B 7
Area . . . . . 3,845 sq. m.
Pop . . . . . 541,987

ÇANAKKALE . . . . . B 6
Area . . . . . 3,645 sq. m.
Pop . . . . . 288,813

ÇANKIRI . . . . . B 9
Area . . . . . 3,507 sq. m.
Pop . . . . . 218,289

ÇORUH . . . . . B 13
Area . . . . . 3,076 sq. m.
Pop . . . . . 174,511

ÇORUM . . . . . B 10
Area . . . . . 4,245 sq. m.
Pop . . . . . 342,290

DENİZLİ . . . . . D 7
Area . . . . . 4,244 sq. m.
Pop . . . . . 340,010

DİYARBAKIR . . . . . C 13
Area . . . . . 5,629 sq. m.
Pop . . . . . 294,618

EDİRNE . . . . . B 6
Area . . . . . 2,240 sq. m.
Pop . . . . . 221,125

ELÂZIG . . . . . C 12
Area . . . . . 3,554 sq. m.
Pop . . . . . 212,400

ERZİNCAN
Area . . . . . 4,086 sq. m
Pop . . . . . 197,460

ERZURUM . . . . . C 13
Area . . . . . 9,244 sq. m.
Pop . . . . . 461,673

ESKİŞEHİR . . . . . C 8
Area . . . . . 5,245 sq. m.
Pop . . . . . 274,571

GAZİANTEP . . . . . D 11
Area . . . . . 3,268 sq. m.
Pop . . . . . 328,082

GİRESUN . . . . . B 12
Area . . . . . 2,630 sq. m.
Pop . . . . . 299,243

GÜMÜŞANE . . . . . B 12
Area . . . . . 3,884 sq. m.
Pop . . . . . 203,474

HAKÂRİ . . . . . D 14
Area . . . . . 3,722 sq. m.
Pop . . . . . 44,204

HATAY . . . . . D 11
Area . . . . . 2,205 sq. m.
Pop . . . . . 296,277

İÇEL . . . . . D 10
Area . . . . . 6,061 sq. m.
Pop . . . . . 317,853

İSPARTA . . . . . D 8
Area . . . . . 3,209 sq. m.
Pop . . . . . 186,152

İSTANBUL . . . . . B 7
Area . . . . . 2,081 sq. m.
Pop . . . . . 1,179,666

İZMİR . . . . . C 6
Area . . . . . 4,952 sq. m.
Pop . . . . . 767,374

KARS . . . . . B 14
Area . . . . . 7,107 sq. m.
Pop . . . . . 409,138

KASTAMONU . . . . . B 9
Area . . . . . 5,491 sq. m.
Pop . . . . . 411,576

KAYSERİ . . . . . C 10
Area . . . . . 6,090 sq. m.
Pop . . . . . 404,650

KIRKLARELİ . . . . . B 6
Area . . . . . 2,599 sq. m.
Pop . . . . . 192,333

KIRŞEHİR . . . . . C 10
Area . . . . . 3,252 sq. m.
Pop . . . . . 182,141

KOCAELİ . . . . . B 8
Area . . . . . 3,257 sq. m.
Pop . . . . . 474,716

KONYA . . . . . D 9
Area . . . . . 18,796 sq. m.
Pop . . . . . 740,595

KÜTAHYA . . . . . C 7
Area . . . . . 5,889 sq. m.
Pop . . . . . 419,100

MALATYA . . . . . C 12
Area . . . . . 7,690 sq. m.
Pop . . . . . 481,386

MANİSA . . . . . C 7
Area . . . . . 5,537 sq. m.
Pop . . . . . 519,319

MARAŞ . . . . . D 11
Area . . . . . 5,827 sq. m.
Pop . . . . . 288,631

MARDİN . . . . . D 13
Area . . . . . 4,476 sq. m.
Pop . . . . . 269,080

MUĞLA . . . . . D 7
Area . . . . . 4,917 sq. m.
Pop . . . . . 240,704

MUŞ . . . . . C 13
Area . . . . . 2,946 sq. m.
Pop . . . . . 107,306

NİĞDE . . . . . D 10
Area . . . . . 5,891 sq. m.
Pop . . . . . 331,061

ORDU . . . . . B 11
Area . . . . . 2,076 sq. m.
Pop . . . . . 372,492

RİZE . . . . . B 13
Area . . . . . 1,415 sq. m.
Pop . . . . . 181,084

SAMSUN . . . . . B 10
Area . . . . . 3,626 sq. m.
Pop . . . . . 475,953

SEYHAN . . . . . D 10
Area . . . . . 6,663 sq. m.
Pop . . . . . 509,600

SİİRT . . . . . D 14
Area . . . . . 4,383 sq. m.
Pop . . . . . 158,838

SİNOP . . . . . B 10
Area . . . . . 2,352 sq. m.
Pop . . . . . 225,427

SIVAS . . . . . C 11
Area . . . . . 11,174 sq. m.
Pop . . . . . 540,412

TEKİRDAG . . . . . B 6
Area . . . . . 2,353 sq. m.
Pop . . . . . 222,916

TOKAT . . . . . B 11
Area . . . . . 4,322 sq. m.
Pop . . . . . 387,456

TRABZON . . . . . B 12
Area . . . . . 1,753 sq. m.
Pop . . . . . 419,148

TUNCELİ . . . . . C 12
Area . . . . . 3,229 sq. m.
Pop . . . . . 105,663

URFA . . . . . D 12
Area . . . . . 7,998 sq. m.
Pop . . . . . 295,734

VAN . . . . . C 14
Area . . . . . 6,857 sq. m.
Pop . . . . . 143,949

YOZGAT . . . . . C 10
Area . . . . . 5,291 sq. m.
Pop . . . . . 323,506

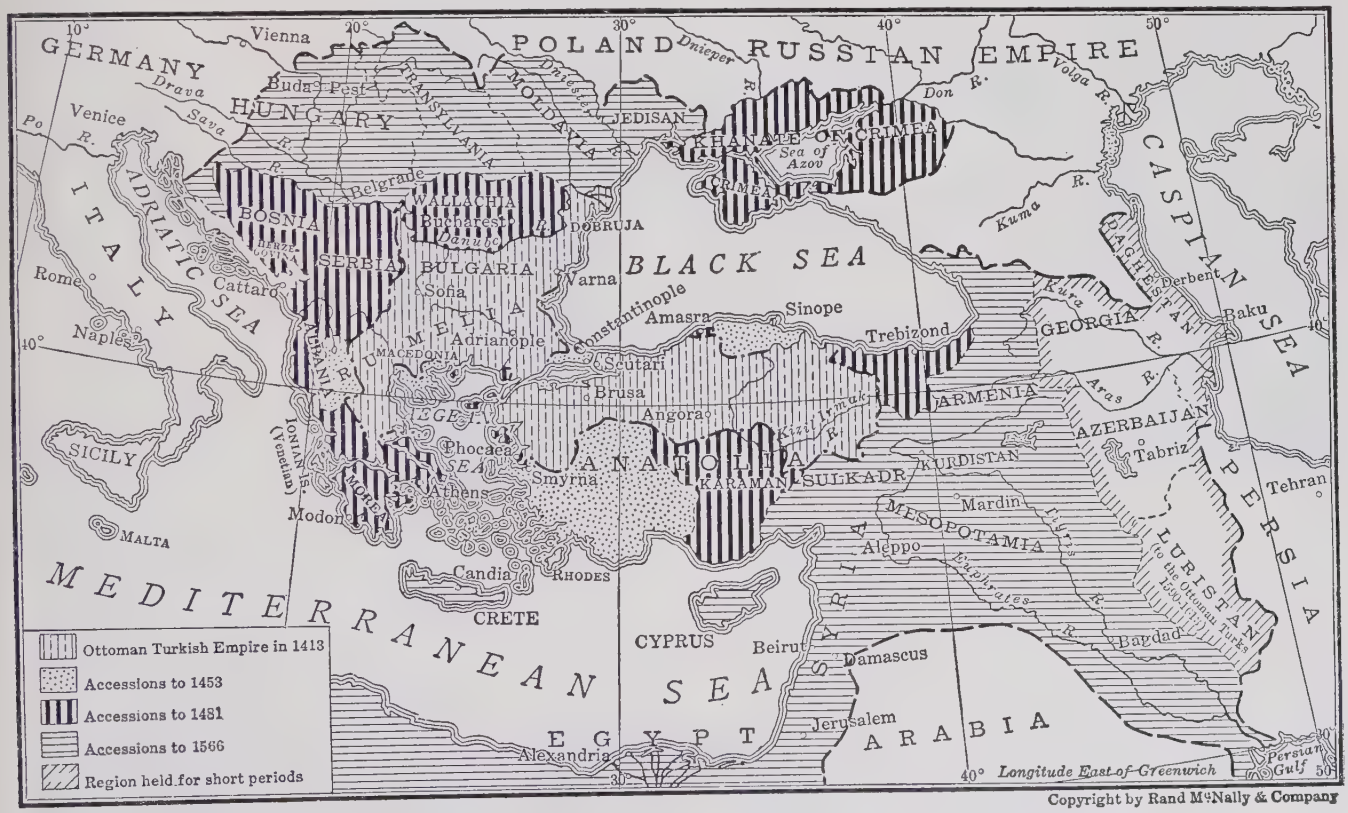
ZONGULDAK . . . . . B 9
Area . . . . . 2,876 sq. m.
Pop . . . . . 425,974

The peak of the Ottoman Empire was reached during the reign of Sultan Suleiman the Magnificent (1520-1566), also called "the Law Giver." He captured the island of Rhodes in 1522, took Belgrade, won a victory over the Persians, defeated the Magyars at Mohács in 1526, and laid siege to Vienna in 1529. He fought with Austria over Hungary, which he incorporated into the Ottoman Empire in 1541, and engaged in pirate warfare with Spain for control of the Mediterranean. France, in the middle of the sixteenth century, became an Ottoman ally and acquired special trading privileges in the so-called Capitulations of 1535. During a three-year war from 1537 to 1540, the Ottomans again defeated Venice. The Ottoman Empire during this period was at its height, ruling over a vast territory including Mesopotamia, Arabia, and Syria in Asia; Egypt, Tunis, Libya, and Algeria in Africa; and the Balkan Peninsula and the Crimea in Europe. The government was shared by two institutions: the Ruling Institution, comprised of neo-Moslems, in charge of political and military functions of the state; and the Moslem Institution, comprised of born Moslems, in charge of spiritual, educational, and judicial functions.

**Decline of Empire.** After Suleiman's death the beginning of decay set in. Selim II, "the Sot" (1566-1574), was an extremely weak ruler. The Allied Christian fleet, including forces of the Pope, Spain, and Venice, defeated the Ottoman fleet at Lepanto on Oct. 7, 1571, marking the first major defeat of the Turks. The disunity among the Christians, however, temporarily saved the Ottoman Empire. The period after Suleiman was one characterized as that of the "passive sultans." There was a growing influence of the serai, grand viziers and ministers being appointed and dismissed under the harem influence. The sale of offices and heavy taxation contributed to political and economic instability. The power of the Janizaries increased; they controlled the government and the sultans. In 1617, a succession law was passed whereby not the son but the eldest male relative of the sultan was to succeed to the throne. During the rule of Selim II clashes on all frontiers of the empire continued. The Ruling and Moslem institutions began to break down, each usurping the other's functions.

The rules of Murad III (1574-1595), Mohammed III (1595-1603), Ahmed I (1603-1617), Mustafa I (1617-1618; 1622-1623), and Osman II (1618-1622) hastened decay and increased chaos. Murad IV (1623-1640) showed a sign of strength when he defeated the Persians and won very favorable booty, but he died on his twenty-eighth birthday. The empire continued to decay under Ibrahim (1640-1648).

The seventeenth century, meanwhile, brought great changes in Europe. Both Spain and Venice were in decline. Although by the Peace of Sitvatorok in 1606 Austria was freed from paying tribute to the Ottoman Empire, the Thirty Years' War from 1618 to 1648 seriously weakened that country. There were also important changes in the Ottoman Empire, among them the rise to prominence of the Kiuprili grand viziers, who attempted to reform the decaying Ottoman state. Mohammed Kiuprili (1656-1661), appointed vizier by Mohammed IV (1648-1687), sought to end the corruption by the use of terror, and some say that 50,000 persons met death as a result. But the wholesale executions failed to curb the influence of the harem and restore the past glory of the empire. Kiuprili resumed the policy of war, which was continued by his son Ahmed (1661-1676), who declared war on Austria, only to be defeated at St. Gotthard in 1664. In 1669, however, he captured Crete, and in 1676, through a war with Poland, he obtained Podolia. Grand Vizier Kara Mustafa (1676-1683) renewed the war with Austria and advanced to Vienna in 1683, but was defeated there by the Polish and allied forces of Jan Sobieski. By order of the

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GROWTH OF THE TURKISH EMPIRE FROM 1413 TO 1566, WHEN IT REACHED ITS GREATEST EXTENT

## RULERS OF TURKEY (FORMERLY OTTOMAN EMPIRE)

| Dates of Rule | | Name of Ruler | Succession | Born | Died |
|---|---|---|---|---|---|
| | | | HOUSE OF OSMAN (OTHMAN) | | |
| 1299 | 1326 | Osman (Othman) I al-Ghazi (the Conqueror) | Son of Ertogrul; founder of the Ottoman Empire | 1259 | 1326 |
| 1326 | 1359 | Orkhan (Orkan) | Son of Osman | 1279 | 1359 |
| 1359 | 1389 | Murad I (Amurath, Mourad) | Son of Orkhan; killed in battle | 1319 | 1389 |
| 1389 | 1403 | Bajazet (Bayazid) I Vilderim (the Lightning) | Eldest son of Murad; died in captivity | 1347 | 1403 |
| 1403 | 1411 | Suleiman (Solyman) | Son of Bajazet I; killed by brother Musa | ? | 1411 |
| 1411 | 1413 | Musa (Moussa, Mousa) | Son of Bajazet I; killed by Mohammed I | c.1376 | 1413 |
| 1413 | 1421 | Mohammed I (Mahomet) | Son of Bajazet I | 1387 | 1421 |
| 1421 | 1451 | Murad II (Amurath, Mourad) | Son of Mohammed I | c.1404 | 1451 |
| 1451 | 1481 | Mohammed II (Mahomet) (the Conqueror) | Son of Murad II | 1430 | 1481 |
| 1481 | 1512 | Bajazet II | Son of Mohammed II; abdicated; assassinated | 1447 | 1512 |
| 1512 | 1520 | Selim I, the Savage | Younger son of Bajazet II | c.1466 | 1520 |
| 1520 | 1566 | Suleiman I (Solyman) (the Magnificent) | Son of Selim I; sometimes known as Suleiman II | 1495 | 1566 |
| 1566 | 1574 | Selim II, the Sot | Son of Suleiman I | c.1524 | 1574 |
| 1574 | 1595 | Murad III (Amurath, Mourad) | Son of Selim II | 1546 | 1595 |
| 1595 | 1603 | Mohammed III (Mahomet) | Son of Murad III | 1566 | 1603 |
| 1603 | 1617 | Ahmed I (Achmet) | Son of Mohammed III | 1589 | 1617 |
| 1617 | 1618 | Mustafa I | Son of Mohammed III; displaced | 1591 | 1639 |
| 1618 | 1622 | Osman II (Othman) | Son of Ahmed I; raised to throne by Janizaries, then strangled by them | 1604 | 1622 |
| 1622 | 1623 | Mustafa I (restored) | Son of Mohammed III; deposed; strangled | 1591 | 1639 |
| 1623 | 1640 | Murad IV (Amurath, Mourad) | Son of Ahmed I | 1609 | 1640 |
| 1640 | 1648 | Ibrahim | Youngest son of Ahmed I; deposed, and killed by son and Janizaries | 1615 | 1648 |
| 1648 | 1687 | Mohammed IV (Mahomet) | Son of Ibrahim; grandmother Kensem and vizier regents | 1641 | 1691 |
| 1687 | 1691 | Suleiman II (Soliman) | Son of Ibrahim; set aside as incompetent | 1642 | 1691 |
| 1691 | 1695 | Ahmed II | Son of Ibrahim | 1643 | 1695 |
| 1695 | 1703 | Mustafa II | Son of Mohammed IV; abdication forced by Janizaries | 1664 | 1703 |
| 1703 | 1730 | Ahmed III | Son of Mohammed IV; deposed 1730 | 1673 | 1736 |
| 1730 | 1754 | Mahmud I (Mahmond) | Son of Mustafa II; placed on throne by Janizaries | 1696 | 1754 |
| 1754 | 1757 | Osman (Othman) III | Son of Mustafa II | 1692 | 1757 |
| 1757 | 1774 | Mustafa III | Son of Ahmed III | 1717 | 1774 |
| 1774 | 1789 | Abdul-Hamid I | Son of Ahmed III | 1725 | 1789 |
| 1789 | 1807 | Selim III | Son of Mustafa III; deposed and imprisoned in 1807; killed after restoration | 1761 | 1808 |
| 1807 | 1808 | Mustafa IV | Son of Abdul-Hamid I; put on throne by Janizaries; dethroned by them in 1808 | 1779 | 1808 |
| 1808 | 1839 | Mahmud II | Son of Abdul-Hamid I | 1785 | 1839 |
| 1839 | 1861 | Abdul-Medjid I | Son of Mahmud II | 1823 | 1861 |
| 1861 | 1876 | Abdul-Aziz | Second son of Mahmud II; dethroned; assassinated or a suicide | 1830 | 1876 |
| 1876 | 1876 | Murad V | Eldest son of Abdul-Medjid I; deposed; insane | 1840 | 1904 |
| 1876 | 1909 | Abdul-Hamid II, the Red | Second son of Abdul-Medjid I; deposed | 1842 | 1918 |
| 1909 | 1918 | Mohammed V (Mehmed) | Son of Abdul-Medjid I | 1844 | 1918 |
| 1918 | 1922 | Mohammed VI | Son of Abdul-Medjid I; last sultan of Ottoman Empire; abdicated | 1861 | 1926 |
| | | | GOVERNMENT OF THE GRAND NATIONAL ASSEMBLY OF TURKEY | | |
| 1920 | 1923 | Kemal Atatürk (Kemal Pasha) | Elected president of provisional government set up in opposition to Constantinople government controlled by Allies | 1880 | 1938 |
| | | | REPUBLIC OF TURKEY | | |
| 1923 | 1938 | Kemal Atatürk (Kemal Pasha) | Elected President; re-elected 1927, 1935 | 1880 | 1938 |
| 1938 | 1950 | Gen. İsmet İnönü | Elected President; formerly Premier, re-elected 1943 and 1946 | 1884 | |
| 1950 | | Celâl Bayar | Elected President; leader of Democratic Party; re-elected 1954 | 1884 | |

sultan, Kara Mustafa was executed. The failure marked a definite turning point in Ottoman history. The decay continued after the end of the Kiuprili reform, and in 1684 Christian Europe, represented by Austria, Poland, and Venice, for the first time united in an alliance against the Turks. From this time on the Ottoman Empire was in steady territorial recession. By the Treaty of Karlowitz in 1699, the Turks lost Hungary and Transylvania to the Hapsburgs, Podolia to Poland, and Morea to Venice. Under Peter the Great, Russia expanded at Ottoman expense to the Black Sea, and throughout the eighteenth century Austria and Russia continued aggression against the Turks. In 1711 the Turks regained Azov from Russia, but in a war from 1715 to 1718 they were defeated by the Austrians to whom, by the peace at Passarowitz in 1718, they lost the Banat of Temesvár. From 1735 to 1739 the Turks defeated the combined Austro-Russian armies and won back parts of Serbia and Walachia.

The Treaty of Kuchuk Kainarji in 1774, which ended the Russo-Turkish War, 1768-1774, was a terrible blow to the Ottoman Empire. The Russians received freedom on the Black Sea and the use of the Straits; they also won a protectorate over Walachia and Moldavia and the Ottoman promise to protect the Christian religion. By the Treaty of Jassy in 1792 Russia added to its Black Sea possessions.

The decline of the empire, principally because of poor organization and corruption, was further hastened by the separatist tendencies of the oligarchs who ruled various provinces, the growing strife between the various branches of administration, the rising nationalist ideas among the subject Christian peoples, the inability of the government to ameliorate the social conditions caused by the disintegration of the feudal regime, and the system of "capitulations" giving foreign traders freedom from Turkish laws and taxation.

In 1798 Napoleon landed in Egypt. In 1804 the Serbs

under their leader Karageorge raised a revolution, leading to two disastrous wars with the Turks in 1806-1807 and 1809-1812; by the Treaty of Bucharest (1812) the Turks were compelled to grant the Serbs partial autonomy. In 1815 the Serbs started another rebellion under Miloš Obrenović and in 1821 began the Greek War of Independence. Another war with Russia (1828) ended in the disastrous Treaty of Adrianople (1829), which gave further commercial rights to Russia, allowed Russian occupation of Moldavia and Wallachia, and recognized Greek independence. A struggle with the beys and insubordinate pashas added to the turmoil. Pasvanoglu of Vidin and Ali Pasha of Janina sought to carve out states within the Empire. Mohammed Ali, Pasha of Egypt, even marched toward Asia Minor. Russian intervention on the behalf of the Sultan spared the Empire, but only at the cost of the Treaty of Unkiar Skelessi (1833), which assured the Russians of a dominant position in the Straits. With the assistance of Western Powers, Mohammed Ali was subordinated in 1839-1840.

France had established itself in Algiers in 1830, and Great Britain was gradually extending its control over the southern parts of Arabia. The Ottomans found themselves victorious in the Crimean War, but the Treaty of Paris (1856) compelled them to relinquish the role of protector of Serbia. For all intents and purposes the Romanian provinces of Walachia and Moldavia were lost. And in the early 1860's there were new wars with Montenegro and uprisings in the Lebanon. In 1875 there were uprisings in the Balkans, which gradually spread. The Turks were guilty of barbarism in suppressing the rebels, and the Bulgarian massacres invoked world-wide indignation. These insurrections led to wars with Serbia and Montenegro, and in 1877-1878 with Russia. By the Treaty of San Stefano (March 1878) Great Bulgaria was established under Russian occupation; and Serbia and Montenegro were declared independent and enlarged. European intervention brought about the Treaty of Berlin (June 1878), which reduced Bulgaria, restored certain lands to Turkey, but recognized the independence of Serbia, Romania, and Montenegro. After 1878 German influence grew rapidly in Istanbul, and the Germans negotiated various economic arrangements, including the Berlin-Baghdad railroad. Disraeli acquired a lease to Cyprus on June 4, 1878, and in 1882 England occupied Egypt. From 1894-1896 a series of Armenian massacres caused European indignation. In 1897 the German-trained Turkish army defeated the Greeks in a short war. From 1903 on there were serious disturbances in Macedonia, which required European intervention and led to abortive efforts to reform Turkey.

**Modern History.** The history of modern Turkey begins in 1876 when Sultan Abdul-Hamid II (1876-1909) granted his empire a constitution. Although this constitution was annulled in the following year, the liberal ideas which had penetrated the Ottoman Empire from the West, and which were supported in Turkey by the Young Turks, retained their strength. The "Young Ottomans," as they were first called, appeared during the reign of Abdul-Hamid II, and organized a Committee of Union and Progress which was widely supported by army officers. Their purpose was to dethrone the sultan and institute reforms. This aim was realized after a year of struggle from 1908 to 1909, when Sultan Abdul-Hamid II was dethroned and a government under the leadership of the Young Turks was established. However, there was little change in the imperial system, and conditions deteriorated when the Young Turks embarked on a policy of Turkification. This policy alienated those who supported the Young Turks. Albanians were no longer content with only autonomy and wanted full independence. Arabs likewise intensified nationalist activity and organized secret societies aimed at destruction of the Empire. In October 1908 Bosnia-Hercegovina, which had been occupied by Austria-Hungary in 1878, was annexed. Bulgaria took the occasion to declare itself entirely independent. In 1911 Italy defeated Turkey and acquired Libya and the Dodecanese. In 1912, the joint Serbian, Bulgarian, Greek, and Montenegrin forces declared war on the Ottoman Empire. As a result of the two Balkan Wars, 1912-1913, Turkey lost all its possessions in Europe except Eastern Thrace.

The financial structure of the Ottoman regime during this period became very precarious, and Germany came forward with a favorable offer of assistance. Following this loan, a secret alliance was formed which brought Turkey into World War I on the side of the Central Powers. Turkey was decisively defeated, and in 1920, under the Treaty of Sèvres, the Ottoman Empire was broken up. Turkey, confined to

*NATION SQUARE, ANKARA*

COURTESY OF THE TURKISH EMBASSY

Asia Minor and to the neighborhood of Constantinople in Europe, seemed about to become a colony of the European power. It was rescued from this by Kemal Atatürk. After Mohammed VI, the sultan, capitulated at Sèvres, Atatürk decided to organize resistance to the terms of the peace treaty as far from Constantinople as possible. His arrival at Samsun on May 19, 1919, is a date honored by the Turks as the beginning of the Turkish National Revolution. At this time the Greeks were occupying Smyrna, and, against overwhelming odds, Atatürk organized an army to drive them out. His success in defeating the Greeks won for Turkey a negotiated settlement at the Lausanne Conference in 1923. By this settlement Turkey reacquired that portion of Thrace which lies east of the Maritsa River.

On Oct. 29, 1923, Turkey was proclaimed a republic and Kemal Atatürk was unanimously elected its president. Atatürk was determined to make of Turkey a modern state on western lines. His Republican People's Party became the only legal party, and his adversaries were one by one ruthlessly crushed. By the time of his death in 1938, great progress had been made in the westernization and industrialization of the country. Atatürk was succeeded in the office of president by former Premier İsmet İnönü, first elected in 1938 and re-elected in 1943 and 1946.

**Recent Developments.** Turkey remained neutral during most of World War II and broke off diplomatic relations with Germany in August 1944, and with Japan in January 1945. The rupture of the Turkish-German relations followed the compliance of the Turkish government with the joint request of the United States and British governments in April 1944 to stop the country's entire export of chrome and other materials to Germany. Turkey entered the war on Feb. 23, 1945, after the Yalta Conference, in order to be permitted to attend the United Nations Conference on International Organization in April 1945.

In 1936, the Conference at Montreux had given Turkey permission to fortify and control the Straits of the Dardanelles. The Soviet Union after World War II charged that Turkey had not fulfilled its responsibility of keeping German ships from entering the Black Sea and demanded revisions of the Montreux Convention. At the beginning of 1945, the Soviet Union renounced the Soviet-Turkish treaty of friendship, which was to have expired on Dec. 7, 1945. Although the United States and Great Britain were not unfavorably disposed to the revision of the convention, they opposed the Soviet demand that it share with Turkey the military defense of the Straits. The situation grew tense when the Soviet Union demanded, among other things, Kars and Ardahan in eastern Turkey, which had once been Russian.

On Mar. 12, 1947, President Truman sent a message to Congress requesting loans to support the governments of Greece and Turkey. In the case of Turkey, the full amount of $100,000,000 was earmarked for the modernization of the Turkish army. It was estimated that 44 per cent of the Turkish budget would be spent for military purposes. This, together with other burdens placed upon the Turkish economy by the military establishment, had given rise in 1947 to fears that the strain would soon become too great for Turkey to maintain economic stability. However, the American loan ended the war of nerves with the Soviet Union. President İnönü used the credits extended to Turkey by the International Bank of Reconstruction for the consolidation of his country's economy and for expediting the development of national industry. In 1949 Turkey joined the Advisory Council of Europe, and in September 1950 Turkey sent a brigade to join United Nations forces in the Korean War.

The election of May 22, 1950, gave a surprising victory to the newly created Democratic Party, whose principal leaders had once been prominent members of the Republican People's Party. This officially inaugurated the two-party form of government. Celâl Bayar was elected president, Adnan Menderes became Prime Minister, and Fuad Köprülü ( a descendant of the ancient Kiuprili family) Foreign Minister. Sweeping reforms were announced, tending to depart from the former rigid statism and allowing more place to private initiative. Concessions were made to religion and to religious education. Industrialization of the country continued and additional distribution of land was envisaged. The foreign policy remained unaltered.

Serious dollar and sterling shortages reduced the Turkish foreign trade potential, but credit and loans from the International Bank for Reconstruction and Development and from the European Recovery Program were extended. In the general elections of 1954 Celâl Bayar and his Democratic Party were returned to office with overwhelming majorities.

In international affairs, the most important events were the signing, in 1954, of a twenty-year military pact with Yugoslavia and Greece, each promising military aid against unprovoked aggression, and in the same year, a mutual security pact with Pakistan, which was extended the next year to include Iraq. The membership of other Arab states of the Middle East in this latter pact was solicited, causing considerable debate and some opposition within the Arab League, but Egypt's efforts to have the League reprimand Iraq was rejected by the other member states. These agreements and Turkey's membership in NATO were strategic diplomatic victories for the Western powers in the Cold War. *See also* Mohammedan Architecture; Mohammedan Art; Turkish Literature; Turkish Music. W. S. V. and J. E. F.

**TURKEY,** a large bird of the class Aves in the genus *Meleagris,* and in the species *gallopavo.* It is indigenous to the continents of the Western Hemisphere, and, becoming readily adapted to domestication, furnishes a palatable and nutritious meat supply for human consumption. The breeding and rearing of domesticated varieties of turkeys is an economically significant part of the American poultry industry. The turkey employed in the commercial enterprise is the descendant of the North American wild turkey, of the family Meleagrididae, within the order Galliformes, in the subclass Neornithes. Turkeys were first seen by white men soon after 1492, at which time they probably had been used by the American Indians as a source of meat food for many generations. At least five subspecies of wild turkeys have been recognized, ranging in original habitat from Mexico to northern New England. Wild turkeys, although considerably reduced in numbers, are still to be found.

The American Poultry Association's (A.P.A.) Standard of Perfection, the recognized poultry-breed standard, lists and gives standards of quality for the Bronze, Narragansett, White Holland, Bourbon Red, Black, and Slate. More or less widely known also are such nonstandard varieties as the Jersey Buff, Nittany, Beltsville Small White, Broad-breasted, Crimson Dawn, Blue, and the Royal Palm. Certain varieties of turkey seem especially well adapted to conditions prevailing in certain areas, so that growers have a wide choice.

The American turkey industry, according to United States Department of Agriculture estimates, grew steadily from an approximate 15,000,000 turkeys raised per year in 1924 to over 44,000,000, weighing 541,000,000 lb., in 1944—4.3 lb. per capita against 28.9 lb. for chickens. In the record year

1946, the consumption was 687,000,000 lb. In 1948, as a result of the abandonment of meat rationing and the general availability of other foods and most consumers' goods, turkey consumption was somewhat below the 1944 level. The Pacific Coast states, the great prairie states, the Mississippi Valley states, and those along the Atlantic Seaboard have developed large centers of commercial turkey production.

The turkey industry has extended beyond the United States and Canada. All turkeys that are bred for commercial purposes are descendants of *Meleagris gallopavo.* There is another genus in the family Meleagrididae, known as *Agriocharis ocellata,* or ocellated (eyelike-spotted) turkey. This native of the Yucatan peninsula of Mexico and adjoining territory remains a creature of the dense forest. A golden turkey has been reported in Peru. W. C. T.

**TURKEY BEARD,** a group, *Xerophyllum,* of tall, stately perennials of the lily family, composed of three species all native to North America. Their strong stems, springing from short, thick rootstocks, are unbranched, very leafy at the base, and bear handsome spikes of innumerable small, fragrant, white flowers. The eastern turkey beard, *X. asphodeloides,* rises to 5 ft., having a thick tuft of very narrow leaves. Its flower cluster is a loose oval, 6 in. long. Native to dry pine barrens from New Jersey to Florida and Tennessee, it is often planted in wild gardens, especially in England. Western turkey beard, *X. tenax,* called also bear grass and squaw grass, often reaches a height of 6 ft. The flowers are creamy white and have violet stamens, and hundreds are crowded on spikes sometimes 1½ ft. long, of solid, yet feathery, appearance. The plant blooms with striking effect on dry mountain slopes from Yellowstone Park to British Columbia, and southward into California. The leaf fibers were formerly used by the Indians in making fine baskets; the roots were roasted for food. J. C. Wis.

**TURKEY VULTURE,** a New World vulture, *Cathartes aura,* occurring in a number of closely related forms from southeastern and southwestern Canada to the Strait of Magellan and the Falkland Islands. It is a large bird (length, 2½ ft.; wing spread, 6 ft.). The plumage is brownish black, except for the silvery underside of the wings and the naked skin of the head and bright red neck. Entirely a carrion feeder, it is protected by law in many areas because of its services as a scavenger. The belief that it is a distributor of disease has been disproved by experiment. A popular name for it is turkey buzzard. H. G. De.

**TURKIC LANGUAGES.** *See* ALTAIC LANGUAGES.

**TURKISH,** more exactly Osmanli or Ottoman Turkish, a language spoken by about 20,000,000 persons, mostly of Turkic stock, and mainly in Turkey and along the Black Sea coast of Bulgaria, but also by minorities in Yugoslavia, Albania, Iraq, and Cyprus. Together with Azerbaidzhanian and Turkoman, Osmanli forms the Southwest or "Orghus" group of Turkic languages, which is a branch of the Altaic family.

The oldest Turkish inscriptions, dating from A.D. 734 or 735, were found near the Orkhon River, south of Lake Baikal in central Asia. A Turkish-Arabic Dictionary was compiled by Mahmud al-Kashgari about 1074, and the Codex Cumanicus of 1303 contains Latin-Persian-Turkish, Turkish-Latin, and Turkish-German glossaries, using a Latin transcription for Turkish. The very old texts are written in a Semitic script of unknown origin, but practically all historical texts are written in the Perso-Arab script that was officially used until 1928. This script was by no means an ideal medium to express the sounds of Turkish, and its shortcomings helped to discourage literacy. To remedy the situation, the first Turkish Language Congress under Kemal Atatürk adopted Latin characters as the official Turkish script but considerably modified the Latin alphabet. The letters *q* and *w* are omitted but the umlauts *ö* and *ü* are used. The symbol *ş* was introduced for the sound of *sh* in *shine, c* was given the value of *j* in *John,* and *ç* was introduced for the sound of *ch* in *church.* Depending on its etymological origin, *ğ* may indicate either a vocal glide, articulated like the *y* in *voyage,* or it may stand for a guttural, as in *dağ,* "mountain"; in the latter case, however, it has dwindled to a mere glottal stop in the dialect of İstanbul. The symbol *ı* (an *i* without a dot, or with a small circle in its place) is used for a full vowel, which may be described as being between *i, e,* and *ö.*

COURTESY OF THE NEW JERSEY AGRICULTURAL EXPERIMENT STATION

*A flock of Monmouth Bronze turkeys on a New Jersey turkey farm*

Encouraged by the enthusiasm that followed the introduction of Latin script and the ensuing spread of literacy, the language congresses of 1932 and 1934, under Kemalist dictatorship and at the height of nationalistic feeling, set out "to put the Turkish language into a form that could be easily learned and understood by everybody" and to bridge the gap between the "fine" dialect of İstanbul and the "rude" *kaba* dialect of the peasants. In 1932 the official Turkish Language Society, *Türk Dil Cemiyeti,* was formed. While some of the Western constructions in grammer were adopted to make the language a better tool for all sciences, the emphasis was on vocabulary. Just before the 1934 congress, the *Tarama Dergisi* dictionary, with an Ottoman Neo-Turkish and a Neo-Turkish Ottoman volume, was published. Persian and Arabic words, wherever possible, were replaced by *kaba* words, obsolete Turkish words, words from other Turkic dialects, or even newly coined words. In 1935 the metropolitan press tried to use the new official language exclusively, but readers found themselves obliged to use the dictionary and were offended by the use of *kaba.* Newspaper circulations soon dropped. A new pocket dictionary was less radical, and the 1936 language congress, preoccupied with proving Turkish to be the mother of all languages, resigned itself to a middle-of-the-road policy. While the extreme aim of the reform movement has not been attained, it has definitely left its imprint on the Turkish language.

**Characteristics.** Agglutination, sound harmony, and

scarcity of conjunctions are among the principal features that Turkish shares with other languages of the Southwest Turkic group.

*Agglutination.* Turkish has a wealth of suffixes for noun, pronoun, and verb inflection without any very strict line between these categories. These suffixes, each of which has only one function, may be added and combined at will without any distinction of declension or conjugation; only their sequence is fixed, and they are subject to vowel harmony. Examples are: *ev* "house," *ev-ler* "houses," *ev-im* "my house," *ev-den* "from the house," *ev-ler-im-den* "from my houses"; *sev* "he loves," *sev-ler* "they love," *sev-iş-dir-il-e-me-ler* "they cannot be made to love one another."

*Sound Harmony.* Turkish has two series of vowels, the "soft" ones *e, i, ö,* and *ü,* and the "hard" ones *a, ı* (*i*), *o,* and *u.* Suffixes, unless still felt as independent words, exist in at least two alternate forms, one with a soft vowel and one with a hard one, e.g., *ev-ler* "houses," but *adam-lar* "men." At the end of a word, before a suffix, *p, t, ç,* and *k,* under certain conditions, can be replaced respectively by *b, d, c,* and either the glide *ğ* or at times *g.*

*Scarcity of Conjunctions.* Co-ordinating conjunctions in Turkish are mostly from Arabic or Persian, and subordinating ones are almost absent. There are, however, many verbal nouns which express the meaning of subordinate clauses quite as well as clauses. There is no definite article, but since case suffixes are used only where a definite article would be used, they take its place. The numeral *bir* "one" serves increasingly for an indefinite article.

*Other Characteristics.* In addition to the principal Turkic characteristics of the language, others may be briefly noted. Gender is not distinguished, *o* standing for "he," "she," or "it." The plural in *-lar* or *-ler* is an innovation. Pronominal expressions of the first and second person still preserve the common Turkic plural ending *-z* (e.g., *ev-im-iz,* "our houses," *sev-im-iz,* "we love"). Every syllable is fully pronounced. The last syllable usually carries the main accent, the first syllable a lighter one.

The main feature that distinguishes Osmanli from other Turkic languages is the vast influence of other idioms. The educated dialect is heavily penetrated with Arabic, Persian, and French; the *kaba* dialect shows more Byzantine influence. Arabic, as the language of the Moslem religion, and the language during the Middle Ages of the arts, sciences, and learning in general, has had a profound influence. Persian was the language of poetry and fiction. When Turkey turned to the West in the nineteenth century, both were replaced by French. In the "fine" Turkish language about 50 per cent of the words used are foreign, in technical texts often 95 per cent.

Since Turkey's defeat in World War I the importance of the language outside of Turkey has been slight. P. F.

**TURKISH LITERATURE,** the literature of the Osmanli or Ottoman Turks. The product of a people who won fame by establishing a vast empire, Turkish literature is comparatively recent in origin, for its first records do not antedate the end of the thirteenth century. However, the ethnic groups of Turkic stock who remained in their original home in Central Asia were active in literary pursuits at a much earlier date.

**Turkic Precursors.** The so-called Orkhon inscriptions in inner Mongolia go back to the eighth century A.D., and only a little later are the fragmentary texts of the Turkic Uigurs, from the caves of Turfan in Chinese Turkestan. Religious in their content, these texts bear evidence of the stupendous variety of the religious influences which expanded along the "Silk Road" linking China to Persia, since Buddhism, Manichaeism, Nestorian Christianity, and Judaism are represented in them. Their script, the so-called Runic alphabet, is of Aramaic origin. However, despite the great historical importance of these scanty remnants of a well-developed culture among the Uigurs, not discovered until the beginning of the twentieth century, they do not belong to literature proper.

It was only after the Turkic peoples were converted to Islam and began to follow the pattern of Persian literature that some attempts at poetical composition were made in Transoxiana and western Turkestan; this took place not earlier than the latter half of the tenth century, chiefly in the dialect of Kashgar, the main political center of the region. The themes generally treated are ethical wisdom and mystic (Sufi) effusions, and neither originality nor style rank very high. This literature was not long-lived, for the Tatar invasion at the beginning of the thirteenth century proved fatal to its further growth. Only the speakers of another Eastern Turkic dialect, the Chagatai, carried on, under overwhelming Persian influence, a noticeable literary activity both in poetry and prose. The most remarkable fruit of this activity is the autobiography of the Mogul Sultan Baber (1483-1530), the conqueror of India.

**Beginnings of Turkish Literature.** The cultural significance as well as the political power of the Turkic peoples was carried to the West by the Osmanli, or Ottoman Turks. They were a numerically small tribe of nomadic warriors who moved from Central Asia to Asia Minor in the thirteenth century, conquered the Balkans during the fourteenth and fifteenth centuries and Syria, Mesopotamia, Egypt, and Arabia in the sixteenth, and were for about four centuries the leading Moslem state and one of the most powerful empires in world history. Their literary achievements, however, fell short of their political importance.

From the very rise of their nation, the Turks were under the spell of the Persian and Arabic traditions. The former supplied them with an artistic background and the latter with a scholarly and religious background, and between them they nearly stifled the independence and originality of the Turks' creative abilities. A substantial number of works which belong to Persian or Arabic literature, because they are written in one or the other of those languages, are actually the product of Turkish authors; some of the most famous among the sultans, including Mohammed I (1387-1421) and Suleiman the Magnificent (c. 1496-1566), composed Persian poems with uncommon skill. Nevertheless, the Turks never lost consciousness of their nationality, constantly used their language for administrative and other nonliterary purposes, and strove to make it fit for artistic expression, even though they did not achieve complete emancipation from Persian models until very recent times.

The oldest attempts at writing Turkish verse go back to the end of the thirteenth century, a collection (*divan*) of mystic poems by Yunus Emreh being considered the earliest example of a book written entirely in Turkish. Emreh tried to substitute metrics based on the count of syllables for the Arabic and Persian quantitative metrics, the latter being quite unfit for the Turkish language. He was unsuccessful, however, and his followers clung faithfully to the foreign system.

**Classical Period.** Turkish poetry reached its peak in the fifteenth and sixteenth centuries, contemporaneously with the expansion of Turkish political power. Among the most renowned poets of that period are Sheikhi (died c.1430),

Nejati (died c. 1500), Mesihi (died 1502), Baki (died c. 1600), and Nef'i (died c. 1635). Of these, the two last attained the widest popularity. Fuzuli (c.1494-c.1555), perhaps the most gifted of them all, composed his poems in Azeri, the dialect of the Persian province of Azerbaidzhan. The merits of these poets, however, like those of all Turkish literature, are purely formal; their inspiration and their contents are wholly Persian.

In addition, an extensive poetical work was written by Yaziji Oghlu Mehmet (died 1451) under the title of *Mehmediyye* ("The Poem of Mohammed"). This is an ambitious description of the world and its history, the Prophet's mission, the foundation of Islam, and the Final Judgment, but it lacks originality of thought and artistic significance. As a curiosity, mention may be made of the *Bahriyye,* a poem on nautical science written early in the sixteenth century by an expert sailor, Piri Re'is (died 1555). Added to it is a map, on which Columbus' travels to America are recorded.

Besides religious and scientific writings which hardly belong to literature proper, the Turks cultivated history extensively, chiefly in the form of annals and biographies of sultans and their ministers. Evliya Chelebi (died c. 1679) wrote a highly interesting and lively report of his travels, the *Siyahet Nameh.* The legendary epic tale, *Sayyid Battal,* originally composed in Arabic, exists also in a Turkish adaptation augmented by the addition of new elements. Most works of fiction are mere translations from the Persian.

During this extended period of subservience to foreign patterns, the native artistic impulse of the Turks found literary expression only in popular writings. In these, genuine aesthetic values were expressed in simple and immediate form, although no author of exceptional stature emerged to mold this uncouth material into a finished work of art. Freshness and spontaneity characterized a kind of popular song called *Mani,* and the jocular and satirical vein of the common people found expression in rather crude dramatic plays. The plays were of three types, known as *Meddah, Orta Oyunu,* and *Karagöz* (the last so named after its principal character, a clown), and were often accompanied by musical performances. They originated probably before the Turkish invasion of Europe and are related to the Arabic shadow theatre; what is known of them now is derived from other sources, for no actual texts of the plays have survived.

**Period of French Domination.** In the nineteenth century, as reforms began to affect the administrative, judicial, and educational policies of Turkey, Turkish literature also entered a new phase. Persian influences began to lose their domination and were gradually replaced by the influences of the Western nations, particularly the French. The leader of the new school of literature in Turkey was Shinasi (1824-1871), who in 1860 started the first Turkish newspaper, *Tercuma-i-Ahval.* He also pioneered in the domain of the drama with his satirical play *Sha'ir Evlenmesi,* the first Turkish literary comedy.

Namik Kemal (1840-1888), a disciple of Shinasi, was more effective as a political figure than as a man of letters. The writer of this period who was responsible for the greatest changes in Turkish poetry and drama, however, was Abdulhak Hamit (1851-1937), a friend and disciple of Namik Kemal. His dramatic works, written under the influence of Racine and Corneille, are unsuited for theatrical performances, but they are emotionally powerful. In the lyric, he abandoned the ancient form and its almost artificial sentimentality, turning instead to descriptive realism. Mehmed Ra'uf (died 1919), a novelist, and Jelal Sahir (1883-1935), a poet, are two of the other noteworthy writers of this period who found inspiration in such French authors as Daudet, Zola, Flaubert, Musset, and Baudelaire.

**Modern Period.** The next phase of Turkish literature, the struggle for nationalism, followed closely upon the revolution of 1908. The aims of this movement were to rid literature and language of all foreign elements and influences. In literature this signified a return to everything Turkish, in characters, settings, situations, and language, but the excesses of the movement soon passed over. The outstanding writers of this period are a woman, Halide Edib, and Yakub Kadri, both of whom depicted the turbulent history of Anatolia, presenting real characters in realistic environment and situations. Halide Edib is perhaps superior to Kadri as a story-teller, while Kadri, who shows the influence of the French novelists Maupassant, Alphonse Daudet, and Paul Bourget, excels in mastery of style. Other writers of importance are the novelist Omar Seyfettin (died 1920) and especially Ziya Gökalp (died 1924), the theoretician of Turkish nationalism and a philosopher and poet of great merit. G. L. D. V. and E. Fr.

**TURKISH MUSIC.** The music cultivated during recent years within the confines of what is now the Republic of Turkey falls into three distinct classes, which at the midpoint of the twentieth century were only beginning to fuse into a homogeneous national musical pattern. The oldest of these classes is itself a conglomeration of musical styles, each developed and sustained over many centuries by one or more of the numerous ethnic groups formed by wave after wave of military conquest, group immigration, and cultural invasion. In addition to the Greeks, Kurds, Armenians, and other foreign groups within the Turkish borders, many different Turkish subgroups contribute to the total body of Turkish folk music. Scorned by the urban, educated ruling minority in the former Ottoman Empire (c. 1300-1923), this music of the Anatolian folk has little in common with the second broad class of recent Turkish music, the *ince saz,* or "refined music," of the erstwhile Ottoman court and with the religious music of the once-great monastic centers.

In contrast to the purely oral folk traditions, the Ottoman art music boasted a highly developed theory and a considerable literature. Far from being merely local in its focus, it was heir to the once-glorious mantle of so-called "Arabic" music, to which Greeks, Turks, Iranians, and Jews as well as Arabs had contributed in medieval times, the Arabic language serving merely as a *lingua franca,* and which exerted its influence from Spain to the islands of the South Pacific. Whereas the various folk music styles show a fondness for relatively stable pentatonic and heptatonic scale formations, the Ottoman art music was based on a complex system of melodic formulas or *makamat,* derived through permutations of an underlying twenty-four-tone scale, of which, however, less than half the tones were used in any given composition. The contrast between rhythmic styles is less marked, both folk and art music displaying varieties and subtleties of a kind unknown to Western music; art music, for instance, possessed a rhythmic system, or *usul,* having about fifty standard metrical patterns as opposed to the half dozen common in European music.

The chief instruments of the Ottoman "refined music" were the expressive, age-old Turkish *tanbur,* or long-necked lute, the soft-toned vertical flute, or *ney,* and the silvery *sine keman,* or "breast fiddle," a Turkish relative of the European viola d'amore. Folk instruments, on the other hand, while including many types and many local varieties within those

types, are represented above all by the shrill, squalling *zurna,* or oboe, and the loud *davul,* a medium or large bass drum. Like unsophisticated music everywhere, Turkish folk music usually accompanies either singing or dancing, whereas the art music has found expression in purely instrumental "concert" suites and individual pieces as well as in extremely florid love and religious songs. The most characteristic form of Turkish music was the once widely-known *mehterhane* or military band, which combined elements of Central Asiatic Turkish music with Southwestern Asiatic folk traditions and Ottoman art music; paradoxically, however, this vital form was abandoned, largely because of its association with the often defeated and outmoded Turkish military organization, about 1825, in favor of the European type of military band, which the *mehterhane* had itself helped to formulate.

The third class of music found in twentieth-century Turkey is Euro-American music in all its phases. Until the final breakdown of the Ottoman Empire following its defeat in World War I, Western music was represented in Turkey almost solely by the military band; between the two world wars, however, President Kemal Atatürk's republican regime carried out a drastic program of westernization which affected music in common with other arts. The Ottoman art music was neglected and at times even banned because of its association with the decadent, outlawed aristocracy; in its place sprang up symphony orchestras, opera, and chamber music, while Western music became a part of the reformed school curriculum and American popular music appeared in the coffee houses. At the same time, Turkish scholars, with the aid of such foreign experts as Béla Bartók, began to study and to codify the hitherto neglected wealth of local folk music traditions, and native composers began to use this material as the basis of a new national music, Western in form but Turkish in substance. *See also* MILITARY MUSIC. W. Li.

**TURKMEN SOVIET SOCIALIST REPUBLIC** or **TURKMENISTAN** [tɜ′rkmɛn, tɜ′rkmɛnɪsta′n], the southernmost constituent republic of the Union of Soviet Socialist Republics. It was inhabited from the tenth century by Turki tribes, of which the Tekke or Teppe were the most important. In 1881 their stronghold of Goek Tepe was conquered and the region was incorporated into Russian Turkestan. In October 1924 it was organized into a soviet republic from the former Trans-Caspian region of Turkestan, the Chardzhou vilayet of Bukhara, and a part of Khiva on the right bank of the Amu Darya. In May 1925 it became a constituent republic of the Union of Soviet Socialist Republics. It is subdivided into the Krasnovodsk, Tashauz, Ashkhabad, Chardzhou, Mary (Merv), and Kerki regions. With an area of 171,042 sq. mi., it is bounded by the Caspian Sea on the west, Kazakh Soviet Socialist Republic on the north, Uzbek Soviet Socialist Republic on the north and northeast, Afghanistan on the southeast, and Iran on the south. The capital is Ashkhabad.

*TURKMENIAN WOMEN IN THE COTTON FIELDS OF ASHKHABAD*

SOVFOTO

SOVFOTO

*A trader and his camel train crossing the Kara Kum, a vast desert area in central Turkmen*

The driest region of the Soviet Union is the Kara Kum (Desert), which forms 85 per cent of Turkmenistan. Along the southern and eastern borders are the Kopet and Karabil mountains. The Amu Darya (the ancient Oxus River) marks part of the boundaries with Uzbek and Afghanistan; the Atrek and Hari Rud form part of the boundary with Iran; and the large Murghab River flows south into Afghanistan. Summers are long and hot, with an average temperature of 85° F.; winters are short and relatively cold, averaging 32° F. The vegetation is sparse coarse grass.

The Kara Kum conditions the economy of Turkmenistan. Most of the cities and farms and 90 per cent of the population are found in the river valleys and oases. Cotton is the leading crop, followed by wheat and alfalfa. Grapes, melons, and garden crops are grown. Livestock raising prevails in the desert, chiefly cattle (2,000,000 in 1945) and the sheep which furnish wool for the famous carpets of the region. Considerable research and experimentation have been conducted to extend agriculture into the desert, and extensive irrigation systems have been initiated.

Turkmenistan's industrial production has increased since 1920. Mineral chemicals characteristic of desert regions abound. Large amounts of sulphur are mined from the enormous deposits near Zaliv Kara-Bogaz Gol, a gulf of the Caspian Sea. Gypsum, clay, limestone, witherite, iodine, and

bromine salts are also found in abundance. Several hundred thousand tons of petroleum are produced annually at Nebit Dag (Neftedag). Glass, fabrics (cotton, silk, and wool), and livestock products are the principal manufactures. A railroad crosses from Krasnovodsk to Chardzhou, and there is a branch line from Mary to Kushka on the Afghanistan border, the southernmost city of the Soviet Union. Pop. (est. 1954), 1,500,000. *See also* TURKESTAN. R. H. F.

**TURKOMAN.** *See* ASIATIC TRIBES (*Ural-Altaic*).

**TURKS AND CAICOS ISLANDS.** *See* CAICOS ISLANDS.

**TURKU** [tʊ′rkʊ] (*Swed.* Åbo), port city and capital of Turku-Pori province, in southwestern Finland, 95 mi. west of Helsinki. The city is situated at the mouth of the Aura River on the flat plain of Ostrobothnia bordering the Gulf of Bothnia. Turku, an important commercial center in the pre-Christian Era, was the scene of the landings in 1157 of Swedish crusaders who Christianized the country. It was captured by the Swedes in 1553 and enjoyed a period of growth and prosperity until 1713. The Russians, under Peter the Great, controlled the city from 1713 to 1743, and Turku, with the rest of Finland, became part of Russia in 1809. The twentieth century has seen the founding of two new universities, the Swedish Åbo Academy (1918) and the Finnish University of Turku (1922), and the development of art and natural history museums and a city library. Turku, which can be kept open during most winters by the use of icebreakers, is an important port for goods from Sweden and other Baltic countries. Cotton textiles, iron, manganese, tobacco, brushes, and paper are manufactured. Turku is the second largest city of Finland. Pop. 1951, 102,804. J. E. V.

**TURMERIC** [tɜ′rmərɪk], *Curcuma longa,* a perennial plant of the ginger family with tuberous rootstocks from which is derived turmeric, used as a condiment and as a dye. It is extensively cultivated in its native India. Short stems bear narrow leaves, 1½ ft. long, and in autumn spikes of pale yellow flowers 7 in. long. Turmeric powder is prepared from a resinous yellow substance found in the older tubers. It is used in chemistry as an indicator for alkalies, but its principal use is as an important ingredient of curry powder. R. P. T.

**TURN-AND-BANK INDICATOR.** *See* AIRCRAFT INSTRUMENTS.

**TURNER, FREDERICK JACKSON** (1861-1932), American historian and professor, was born in Portage, Wis., Nov. 14, 1861. He graduated from the University of Wisconsin in 1884 and received his Ph. D. degree at Johns Hopkins University in 1890. He was at Wisconsin until 1910; thereafter he taught at Harvard University until 1924, when he became a research associate at the Henry E. Huntington Library in California. Turner was a remarkable teacher with many devoted students. His writings were generally in essay form, but he did complete a volume, *Rise of the New West 1819-1829* (1906), for the American Nation series. Another volume, *The United States—1830-1850, The Nation and Its Sections,* was published posthumously in 1935. Much of his history was an elaboration of his essay, "The Significance of the Frontier in American History." In opposition to the conventional approach of historians in that period, Turner said that the true point of view from which to study American history was not the Atlantic coast, but rather "the Great West." In 1933 he was posthumously awarded the Pulitzer Prize for his *The Significance of Sections in American History* (1932). He died in Pasadena, Calif., Mar. 14, 1932. M. K.

**TURNER, JOSEPH MALLORD WILLIAM** (1775-1851), English painter and engraver, was born in London, Apr. 23, 1775. After a sporadic elementary education, Turner devoted himself to the study of art and entered the Royal Academy schools in 1789. He was elected a member of the Academy in 1802, and, as teacher from 1808 of an Academy course in perspective, he exerted a powerful influence on the development of English landscape engraving. He traveled a great deal, especially in Italy, and found inspiration for many of his later paintings in Venice. His ardent admirer, John Ruskin, devoted some of the most eloquent passages of *Modern Painters* (1843-1860) to a description of his work.

*JOSEPH MALLORD WILLIAM TURNER*

FROM AN ENGRAVING BY W. HOLL

COURTESY OF THE NEW YORK PUBLIC LIBRARY

Trained by the sound architectural draughtsman and topographical artist Thomas Malton, Jr., and developing under the influence of the great seventeenth-century landscapists, Turner extended English topographical painting beyond the antiquarian and reportorial limits, transforming it into a Romantic expression of his own feelings. Graphically this took form most clearly in his hundreds of water colors; in them spatial extent appears bathed with atmosphere and light. The effects he achieved in water colors Turner transferred to oil painting as well. His colors, often of high intensity, retain their relative values effectively and, when coupled with his accurate drawing of shapes, as in the early *Derwenter, with the Falls of Lodore* (c.1797; London, Tate Gallery) or the late *Norham Castle—Sunrise* (c.1835; London, Tate Gallery) are kept within control by the artist. In 1807, Turner began a series of etchings and mezzotints from his own drawings, for a book to be entitled *Liber studiorum.* The work, discontinued in 1820, grew out of his admiration for Claude Lorrain's *Liber veritatis.* Turner died at Chelsea, Dec. 19, 1851, regarded as the titular co-founder, with Thomas Girtin, of English water-color landscape painting. C. P. P.

**TURNIP,** *Brassica rapa,* a biennial herb of the mustard family widely cultivated as a vegetable. There is nothing definitely known about the origin of the turnip, but it is probably a native of northern Europe. In the first season the flattened, white-fleshed, tuberous root produces a tuft of long basal leaves; during the second season or late in the first season, the plant produces a stout stem to 18 in. high bearing yellow flowers and seed pods 2½ in. long. Turnips succeed best in deep, rich, well-drained, light, loamy soil and are easily

grown, thriving best in cool weather, either spring or fall. Early varieties mature in sixty days; late sowings should allow a similar period for growth before frost. V. A. T.

**TŬRNOVO, TIRNOVO,** or **TRNOVO** [ts′rnovo], a city in north central Bulgaria, 80 mi. northeast of Plovdiv, in the sheltered valley of the Yantra River, a tributary of the Danube which has cut a deep, sinuous valley across the northern plateau of Bulgaria. The city has been built in terraces on the steep valley sides and on the narrow flood plain of the Yantra, as well as on two promontories known as Trapezitza and Tsarevitza. Trapezitza, across the river from the city proper, is reached by bridges. Tsarevitza is connected to the city by a causeway. Tŭrnovo was probably a Roman fortress town, and it was the capital of Bulgaria for more than two centuries before its capture by the Turks in 1394. Bulgaria was proclaimed a principality and its constitution was formulated at Tŭrnovo in 1879; establishment of the independent kingdom of Bulgaria was announced there in 1908. Tŭrnovo is a market center for surrounding agricultural regions. One of the local industries is a cotton cloth and thread mill. The city is located near the northern approaches to Shipka Pass and on the roadway using that route. Pop. 1945, 16,182. E. St.

**TURNSTONE,** either of two species of medium-sized (9-in.) wading birds in the genus *Arenaria,* which show alliance to both the sandpipers and plovers. *A. interpres* breeds on arctic coasts and islands around the world and winters on the shores of continents and islands from the North Temperate Zone south to Chile, Australasia, India, South Africa, and Brazil. It has a striking plumage of black, white, and rufous, and has red-orange feet. It is frequently called "calico back" because of its color pattern. The black turnstone, *A. melanocephala,* breeds on the coasts of western and southern Alaska and winters from southeastern Alaska to Lower California. It is marked in a bold pattern of black and white. Unlike the other species, it keeps to rocky ledges. H. G. De.

**TURNUS.** *See* AENEID; VERGIL (PUBLIUS VERGILIUS MARO).

**TURPIN, RICHARD (DICK)** (1706-1739), English robber, was born in 1706 at Hempstead, Essex, where his father was an innkeeper. He was apprenticed to a butcher, but, having been caught stealing some cattle, he joined a gang of smugglers and deer-stealers. When this gang broke up, he entered into partnership with a highwayman, Tom King, in 1735. Turpin accidentally shot and killed his partner, however, and escaped to Yorkshire, where he became a horse trader. In 1739 he was imprisoned for horse stealing, found guilty, and condemned to death. He was hanged on Apr. 7, 1739. The legend of Dick Turpin's ride from London to York on Black Bess, as told in Harrison Ainsworth's romance, *Rockwood* (1834), is fictitious. C. W. D.

**TURQUOISE,** a robin's-egg- or greenish-blue mineral, a hydrous phosphate of aluminum and copper. It has a hardness of 5-6 and a variable density of 2.6-2.8. The mineral crystallizes in the triclinic system and when found is usually massive in form. The indices of refraction are 1.61-1.65. Turquoise is usually fashioned into beads, where the highly polished material with the pleasing color blends well when set with cut or cabochon rubies, sapphires, or emeralds. This semi-precious gemstone is very popular and therefore commands a good price. For centuries, fine turquoise has been mined in Persia. The Sinai Peninsula and Turkestan also yield this mineral. Nevada, New Mexico, and California supply a greenish-blue turquoise that is mined, cut, and polished by native Indians for sale to tourists as well as to the jewelry industry. Ceramic imitations of turquoise do not fade with the passage of time. A. E. A.

**TURTLE,** a member of the reptilian order, Testudinata or Chelonia. Turtles evolved over 160,000,000 years ago as toothed land reptiles; they flourished during later ages, losing teeth, perfecting armor, and developing fresh-water and seafaring branches. Today, there are less than 300 surviving species distributed among twelve families. Although living species are few, individuals are often numerous, particularly in warm, sluggish fresh waters.

Turtles have had a distinctive appearance for millions of years. The short, broad body is incased in a boxlike bony

COURTESY OF THE AMERICAN MUSEUM OF NATURAL HISTORY

*Leatherback,* Dermochelys coriacea, *the largest existing sea turtle, reaches a length of 8 ft.*

shell having upper (carapace) and lower (plastron) parts. If the shell is commodious enough to afford complete protection to head and limbs, the species is rarely aggressive; however, incompletely armored turtles often bite readily, their powerful jaws being capped with sharp-edged horny sheaths in place of teeth. Turtles, including aquatic species, breathe by lungs. Some water tortoises use the air dissolved in the water, and do not come to the surface so often to breathe.

Reproduction is always by eggs, which are spherical and covered by a tough, membranous, or hard, brittle shell. They are buried in sand or loose earth, and usually hatch in a few months; sometimes the young may not emerge until the following spring.

Many turtles are valuable to man. Large marine species yield flesh, shell, and oil (from eggs). Several species of fresh-water turtles are highly prized as food. M. G. N.

**TURTLE CREEK,** a borough in Allegheny Co., in southwestern Pennsylvania, located 12 mi. southeast of Pittsburgh, near the Monongahela River, a part of the industrial district of greater Pittsburgh. The territory was included in the hunting grounds of the Iroquois Indians and had no permanent Indian settlements until after 1722. The district was the scene of much fighting in the French and Indian War; and Sycamore Street in Turtle Creek follows the course of a military road built through the area in 1763 to Fort Pitt. The borough's first permanent white settler was Martha Miers, a widow who received a land grant from

the Penn family in 1769. The community, incorporated in 1892, has the mayor-council form of government. The Pennsylvania and Union railroads serve this industrial borough, whose factory output consists of electrical and railway equipment and steel. Pop. 1950, 12,363.

**TURTLEHEAD,** a small group, *Chelone,* of perennial plants of the figwort family, which owe their common name to the somewhat strange appearance of the flower. There are three species, all native to North America and sometimes grown in gardens. The plants reach a height of 2 to 3 ft., and have pointed toothed leaves and large white or purple flowers in short, crowded, leafy spikes. The white turtlehead, *C. glabra,* is common in swamps and along streams east of the Great Plains; the purple turtlehead, *C. lyonii,* is native to the southern Appalachians; and the red turtlehead, *C. obliqua,* occurs in the southeastern United States. *Penstemon nemorosus,* the so-called western turtlehead, bearing violet-purple flowers, was formerly classed with this group. J. C. Wis.

**TUSCALOOSA** [tʌskəlu′sə], a city in west central Alabama, the county seat of Tuscaloosa Co., situated on the Black Warrior River, 60 mi. southwest of Birmingham. The first permanent white settlement on the site was made in 1816 by a group of ten from Tennessee. Incorporated as a city in 1819, Tuscaloosa served as the state capital from 1826 to 1846. During the Civil War the community was raided by Union troops in 1865, and the buildings of the University of Alabama, which had opened in 1831, were burned. In 1869 the university was re-established. Tuscaloosa is also the seat of the Stillman College for Negroes. The city's hospital facilities include Bryce State Hospital for the insane, Partlow State School for the feeble-minded, an army hospital, and a veterans' hospital. Sites of interest in or near the city include Smith Hall, the university's museum; Gorgas Home, home of Brig. Gen. William C. Gorgas; and Mound Park, 16 mi. south of the city, which contains a group of 34 Maya Indian mounds on a 300-acre tract of land preserved in co-operation with the National Park Service. The city is served by the Southern, the Gulf, Mobile and Ohio, and the Louisville & Nashville railroads. Cotton growing, coal mining, and lumbering are interests of the region, and the manufacture of paper, rubber, chemical, and lumber products are the city's chief industries. Pop. 1950, 46,396.

**TUSCAN ARCHIPELAGO,** a group of seven islands and several islets and shoals in the Tyrrhenian Sea between Corsica and the Italian mainland. They are the peaks of a bridge of land which connected Tuscany with Corsica, Sardinia, and North Africa in the Pliocene Age, but which was submerged in the Quaternary epoch. The islands and their areas in square miles are: Elba, 85; Giglio, 8½; Capraja, 7½; Montecristo, 4; Pianosa, 3½; Giannutri, 1; and Gorgona, 1, making a total of 110½ sq. mi. The population is about 40,000. Giannutri is the southernmost island; Gorgona is the northernmost and wholly mountainous, reaching an altitude of 1,050 ft. in Punta Gorgona. This island was settled in ancient times by Christian refugees and monks; it later passed through several hands, notably those of the Pisans and Florentines, until under united Italy it was made an agricultural penal colony. Gorgona's free population lives by fishing and artisanry. The island forms part of the commune of Leghorn, and before World War II had a population of about 250. *See also* Elba; Giglio; Leghorn (*Province*); Montecristo; Pianosa; Piombino. R. G. W.

**TUSCAN ORDER.** *See* Architectural Orders.

**TUSCANY** [tʌ′skəni] (*Ital.* Toscana), in north central Italy, one of the modern Italian regions. It is bounded on the north by Emilia, on the east by the Marches and Umbria, on the south by Latium and the Tyrrhenian Sea, and on the west by Liguria and the Ligurian Sea. The Apennine Mountains form the boundary on the north, except northeast of Florence, where the region includes a strip on the northern side of the divide. Tuscany has an area of 8,879 sq. mi. and embraces the nine provinces of Arezzo, Siena, Grosseto, Livorno (Leghorn), Pisa, Lucca, Pistoia, Firenze (Florence), and Massa e Carrara.

**Geography.** Tuscany is essentially a region of mountains and hills, the only large lowland areas being the lower Arno Valley and the coastal zone called the Maremma. In addition to the Apennines, there are the Apuanian Alps east of Massa and Carrara, the isolated Monti Pisani between Lucca and Pisa, the Metallic Hills (Colline Metallifere) between Siena and the Tyrrhenian Sea, the low Chianti Mountains south of Florence, the Pratomagno range east of that city, Monte Amiata in the south, and others. Besides the Arno and its principal tributaries (Era, Elsa, Bisenzio, and Sieve), the chief rivers are the Serchio, draining the valley of the Garfagnana north of Lucca, and the streams draining into the Tyrrhenian Sea. Off the coast lies the Tuscan Archipelago, consisting of the islands of Elba (the largest), Gorgona, Capraja, Pianosa, Montecristo, Giglio, and Giannutri.

**Climate.** The climate varies according to altitude, but in general is moderate, showing strong marine influence from the west; protection is afforded from hard winters by the mountains to the north. A few snowfalls occur each year in the hill country and more frequently in the mountains. The typical average annual rainfalls are: Florence, 35 in.; Grosseto, 26 in.; and Camaldoli, in the mountains, 70 in. Fall and winter are the rainy seasons, with summers generally dry, especially in the Maremma on the coast.

**Population.** The estimated population in 1947 was 3,098,000. The 1936 census gave a density of around 355 per square mile, somewhat below the national average. However, the density varies greatly within the region. The most heavily populated zone is the lower Arno Valley from Florence to the sea, plus the Tyrrhenian coast from Carrara to Cecina. Regions of heavy density are also found around Siena, in the Chianti district, and in the iron-mining and smelting zone on Elba Island. Southern Tuscany is generally low in density of population. There has not been a heavy outflow of emigrants from Tuscany, except from Lucca and from Massa e Carrara. In 1913, the peak year for emigration, 40,000 left the region, but mostly for temporary work in other European countries. About one third of the inhabitants of Tuscany live in scattered dwellings, the rest in urban centers.

**Economic Life.** Tuscany is a predominantly agricultural region, highly productive and with almost no barren land. Not all of the productive land is in cultivation, but in recent decades swampy areas in the Arno and other valleys, and in the Maremma along the coast, have been reclaimed. About 30 per cent of the land is in the mountains, 60 per cent in hilly country, and 10 per cent on the plains. One half of the farmland is operated on shares, *mezzadria.* Out of 254,144 farm units before World War II, 115,480 were operated by their owners, and 106,695 by share-farmers. Wheat is the leading product, followed by corn, rye, and oats. Important also are vegetables, olives, and grapes. The more famous wines include those of the Chianti area, and Montepulciano.

Silkworms are raised in the lower Arno Valley and around Siena. Tuscany is the most heavily forested of all Italian regions, despite considerable deforestation during the last two centuries; chestnuts grow in a large part of the wooded area. Tuscany is not a pastoral region and possesses comparatively small numbers of livestock, including 400,000 cattle and 900,000 sheep. Fishing is carried on from several ports along the Tyrrhenian coast.

The output of the iron mines on Elba Island represents nine tenths of that of the entire country. Mercury is mined on Monte Amiata and boric acid is obtained from the mineral hot springs at Larderello, near Volterra. Near the latter are also salt mines, from which about 100,000 tons are taken yearly. The low-grade lignite deposits were worked for about 500,000 tons a year before World War II. The most valuable of the region's mining resources is the marble quarried in the Apuanian Alps, east of Massa and Carrara.

Manufacturing is not a leading activity in Tuscany and only about a third of the working population is engaged in industry, very broadly defined. Electricity is produced only in moderate quantity, about half by water power and half by steam; there are lignite beds and hot springs at Larderello. The iron ore of Elba is largely smelted at Piombino and Portoferraio. Leghorn possesses famous shipbuilding yards, while Pisa and Empoli are noted for their glass. Prato is one of Italy's leading wool-manufacturing centers. Florence produces a variety of articles, including ceramic goods and art goods. The latter are also turned out in many other cities and towns where the old craftsmanship survives.

The railway network is adequate, except in the province of Grosseto, where population is sparse and much land is uncultivated. In 1934 the new *direttissima* from Florence to Bologna, requiring thirty-seven tunnels and constituting a major engineering feat, was opened; it cuts 20 mi. from the distance and an hour and a half from the time required via the old Porretta line. The highway system was expanded and improved following World War I, and the *autostrada* from Florence to the sea via Pistoia and Lucca was constructed. Leghorn is the fifth port in Italy. Smaller harbors in Tuscany are Portoferraio, Viareggio, Marina di Carrara, and Porto S. Stefano.

**History.** In pre-Roman times that part of the region in the vicinity of the lower Arno was a border zone between the Ligurians and the Etruscans. The latter were subjected to Rome in the middle of the fourth century B.C., and the name Tuscia came to be applied to the region. After the decay of the Roman Empire, Tuscia was invaded by Goths, Byzantines, and Lombards, whose wars devastated wide tracts. The Lombards (568-774) and the Franks managed to preserve fairly intact the administrative unity of Tuscany, with Lucca as the chief city. The feudal line installed by the Franks ended in 1115, on the death of Matilda of Tuscany. By bestowing her domain on the Holy See, she initiated a long struggle between the popes and the emperors, of which the net result was the rise in power of the cities, e.g., Pisa, Lucca, Florence, and Siena, and the destruction of the political unity of Tuscany.

*The Villa Medici in Fiesole, Tuscany. The city of Florence is seen in the distance.*

COURTESY OF THE ITALIAN NATIONAL TOURIST OFFICE

Among the cities, Lucca and Pisa, usually at swords' points, led during the eleventh and twelfth centuries, with the latter victorious in the Arno Valley but defeated by Genoa on the sea in the battle of the Meloria in 1284. In the early thirteenth century Lucca appeared to be headed for Tuscan hegemony under Uguccione della Faggiuola and Castruccio Castracani degli Antelminelli. But soon Florence, which had domination over Pistoia and Arezzo, resumed her forward march. Pisa lost its independence in 1406 and Siena in 1559. The primary instrument of this Florentine expansion was the Medici family, who in effect ruled the city from the early fifteenth century to the middle eighteenth century, with short intermissions from 1494 to 1512 and from 1527 to 1530. The title of Grand Duke of Tuscany was accorded Cosimo I in 1569 and recognized by the emperor in 1575. Some of the Medicean line sought to improve economic and agricultural conditions, but in general they did not contribute much to their subjects' welfare. The family was extinguished with the death of Giovan Gastone in 1737, but not until it had achieved some notoriety through its connections with other dynasties, particularly in France.

The rule passed to the house of Lorraine under Francis I, husband of Maria Theresa and Holy Roman Emperor after 1745, who was represented at Florence by regents. He died in 1765 and was followed by his son Leopold II, whose high capabilities were supplemented by a reformer's zeal in political affairs and economic development. Upon becoming

the Roman emperor in 1790, he bestowed the Grand Duchy of Tuscany upon his son Ferdinand III.

A period of upheaval was ushered in by the French Revolution and its armies. The first French invasion, 1799, was soon repelled, but in 1800 Napoleon's forces were back, and in 1801 Tuscany was made the Kingdom of Etruria within the Spanish domain. From 1807 to 1809 it was a French department, but in the latter year Napoleon's sister, Elisa Bacciocchi, became Grand Duchess. In 1814, Ferdinand III returned and failed to support the blindly reactionary policies evident in so many other European states at the time. He was followed in 1824 by his son Leopold II, who in 1848 acceded to the revolutionary movement of the times by granting a constitution. In February 1849 the proclamation of a republic obliged him to flee to Gaeta, whence he returned a few months later under protection of Austrian arms. He withdrew the constitution in 1852, and in 1859 was obliged by the pro-Italian fervor of his subjects to leave again. A provisional government declared war on Austria and, despite French pressure to readmit Leopold, voted for the annexation of Tuscany to the Kingdom of Sardinia, which in 1861 became the Kingdom of Italy. R. G. W.

**TUSCARORA.** *See* INDIAN TRIBES, NORTH AMERICAN (*Eastern Woodland*).

**TUSCARORA WAR** [tʌskərɔ′rə] (1711-1713), an attempt by the Tuscarora Indians living in North Carolina to wipe out the white people in that area. A powerful tribe of the Iroquois family, they had several villages and over a thousand warriors. In 1711, encouraged by the French, they began their attacks. However, nearly 400 of the Indians were killed early in 1712, which prompted them to make a treaty with the white settlers. The treaty was soon broken, however, and the Tuscarora were defeated again in 1713 by North and South Carolina troops. This time the power of the Indians was broken, for 800 of them were captured. The remnants of the tribe fled north of the Ohio River and there joined the Iroquois Confederacy, becoming the "sixth" nation. M. Je.

**TUSCULUM COLLEGE** [tʌ′skyuləm], an accredited, coeducational, privately controlled college, affiliated with the Presbyterian Church. It occupies 122 acres in the suburbs of Greeneville, Tenn. The charter was granted originally to Greeneville College in 1794, and first instruction was given two years later. A merger with Tusculum Academy in 1896 resulted in a change of name to Greeneville and Tusculum College. The name was changed to the present form in 1913. Only the A.B. in liberal arts is awarded. The offerings in the departments of business administration, physical education, and religious education, particularly, have been expanded within recent years. Dormitories have been provided and residence in them is required of all except day students. A small number of scholarships are available. *For statistics see* COLLEGES AND UNIVERSITIES. J. R. To.

**TUSCUMBIA** [tʌskʌ′mbiə], a city in northwestern Alabama, the county seat of Colbert Co., situated on the Tennessee River, 108 mi. northwest of Birmingham. The city, founded in 1817, had the commission form of government in 1951. It is the birthplace of Helen Keller. Cotton, corn, and cattle are raised in the area, and the chief manufactures are fertilizers and aluminum and rubber products. Wilson Dam at Muscle Shoals is 4 mi. north of the city, which has transportation facilities supplied by the Southern Railway. Pop. 1950, 6,734.

**TUSHINGHAM, SIDNEY** (1884- ), English etcher and painter, was born in Burslem, Staffordshire, in 1884. Following a family tradition which went back to the early eighteenth century, Tushingham at the age of fourteen became an apprenticed porcelain painter, attending at the same time the Burslem School of Art. In 1905 he entered the Royal College of Art in London, and studied under G. Moira and Sir Frank Short. Under the latter, Tushingham made dry points and etchings. An accurate architectural and landscape draughtsman, Tushingham has done many views, especially Venetian and Spanish scenes, and many portraits of children. Among his notable prints may be mentioned *Noonday Rest, Venice* (1926), *Florence* (1931), *Plaza San Martin, Segovia* (1932), *Puerta del Puente, Cordova* (1933). J. S. By.

**TUSKEGEE** [tʌski′gi]. *See* INDIAN TRIBES, NORTH AMERICAN (*Southeast*).

**TUSKEGEE INSTITUTE,** an accredited, coeducational, privately controlled technological college for Negroes. It is located on a campus of 110 acres in Tuskegee Institute, Macon Co., Ala. The college was founded by Booker T. Washington in 1881, the year that the legislature of Alabama passed an act to establish a normal school. Under the name Tuskegee Normal and Industrial Institute, combined vocational and classroom instruction was given from the beginning on the high-school level. College courses started in 1923, and the high-school department was discontinued in 1939. The name was changed to the present form in 1937. The numerous divisions of the institute were founded as follows: School of Agriculture, 1923; School of Economics, 1923; Summer School, 1923; School of Education, 1925; School of Mechanical Industries, 1925; School of Nurse Training, 1926; School of Physical Education, 1930; and School of Veterinary Medicine, 1945. Land owned in addition to the campus includes 600 acres of cultivated farmland, 1,140 acres of pasture and woodland, and the 1,700 acres of the Russell Plantation. The co-operative work-and-study courses in agriculture, commercial dietetics, and mechanical industries extend the undergraduate period to five years. Graduate work leading to the master's degree is given in agriculture, home economics, and education. The library contains a large collection on the history and life of the Negro, an agricultural and trade collection, an art gallery, and a museum of African art.

Many fellowships and scholarships are offered and there are some graduate research assistantships and fellowships for work in chemistry provided by the George Washington

*Tompkins Hall, which houses the dining and recreation facilities for the students and faculty of Tuskegee Institute*

Carver Foundation, supplemented by grants from several industrial corporations. Dormitories are provided for men and women. *For statistics see* COLLEGES AND UNIVERSITIES.

J. R. To.

**TUSSOCK MOTH,** the common name given to many members of the family Lymantriidae. The name is derived from the fact that the caterpillars have large tufts and long pencils of hair on the body and thorax, usually two long pencils in front and one behind, as in the genus *Hemerocampa. H. leucostigma* is a common species in eastern North America, while *H. vetusta* occurs on the west coast. The female is wingless and lays her eggs in a white, frothy mass, usually on the cocoon from which she has emerged. They are often serious pests, occurring in such numbers as to defoliate trees. Many of the larvae are provided with barbed, poisonous hairs that produce an irritating skin rash. Related forms are the gypsy moth and browntail moth, both of which, together with the satin moth, have been accidentally imported from Europe. C. H. Cu.

**TUTANKHAMEN (TUTENKHAMON)** [tu′tɑŋkɑ′mən, tu′tɛŋkɑ′mən] (c. 1364-1346 B.C.), Egyptian pharaoh, of the Eighteenth Dynasty, was born about 1364 B.C. He is a minor figure in Egyptian history, but discovery of his tomb by British archaeologists in 1922 created a sensation because it was one of the few royal tombs in Egypt which had not been plundered by grave robbers. Tutankhamen was an Egyptian of noble birth who married the third daughter of the famous heretic pharaoh Ikhnaton. Since Ikhnaton had no sons, Tutankhamen, as the husband of a princess, became a logical candidate to succeed him. A mere boy at the time of his accession in 1355 B.C., he ruled for nine years and was only about eighteen when he died in 1346 B.C. Because of his youth he exercised little authority, and his reign was characterized by a conservative reaction against the Aton-worship which Ikhnaton had tried to establish. Tutankhamen began to rule under the name of Tutankhaton, but as the priesthood of Amon (Amen)-Ra regained its old influence, the young pharaoh was forced to change his name to Tutankhamen. T. B. J.

**TUTELO.** *See* INDIAN TRIBES, NORTH AMERICAN (*Eastern Woodland*).

**TUTICORIN** [tu′tɪkorɪ′n], a port city at the southern tip of India, in Madras State, located about 100 mi. south of Madura, on the Gulf of Mannar, across from Ceylon. The first Europeans to occupy the city were the Portuguese in 1540. They were followed by the Dutch, and the English captured the port in 1825. Tuticorin, Madras' second port, serves as the shipping point for goods being shipped to and from Colombo on the island of Ceylon. It is also a pearl-fishing center and a market for the district's cotton, rice, millet, Palmyra fiber, dried fish, cement, and asbestos products. It is the east-west terminus of the railroad crossing southern India. Pop. 1951, 98,866. J. E. F.

**TUTTI.** *See* MUSICAL TERMS.

**TUTUILA** [tu′tuɪ′lɑ], an island belonging to the Samoan group, northeast of the Fiji Islands in the South Pacific Ocean at 14° 20′ S. lat. and 170° 45′ W. long. Tutuila, together with other islands in the group east of it, belongs to the United States. It is 17 mi. long and 5 mi. wide. The remarkably fine, beautiful harbor on the south side, where Pago Pago is situated, is the submerged crater of an extinct volcano. Although the island is small and mountainous, it contains about 10,000 Polynesian natives living in scattered villages both on the coast and in the interior. Most of them are subsistence farmers. Copra is the only important export, aside from articles of native handicraft sold to tourists who stop briefly in Pago Pago on the regular steamship run from California to Australia. Pop. 1950, 15,556. R. G. B.

**TUVA AUTONOMOUS OBLAST (REGION)** [tu′və], formerly the Tannu Tuva People's Republic, an administrative unit of the Russian Soviet Federated Socialist Republic, in the south central section of the Asiatic Soviet Union. It is bounded on the north by Khakass Autonomous Oblast and the Krasnoyarsk and Irkutsk oblasts, on the east by the Buryat-Mongol Autonomous Soviet Socialist Republic, on the south by Outer Mongolia, and on the west by the Oirot Autonomous Oblast. It has an area of almost 80,000 sq. mi. Following the Chinese Revolution of 1911 the Tuvinians, once called the Uriankhai, declared their independence. But their sovereignty was short-lived, for, despite the protests of China, Tsarist Russia absorbed the country in 1913. The disruption of Russia by the Revolution of 1917 led to the recognition of an independent Tannu Tuva. However, after 1920 the economy of Tannu Tuva appears to have come increasingly under Soviet influence. Numerous Russian scientific and engineering expeditions visited the area, and in 1921 the Tuvinians chose to call their country the People's Republic of Tannu Tuva. This development was subsequently recognized officially by the Soviet Union and the Mongolian People's Republic. In October 1944 this protectorate, as it was in essence, was incorporated into the Soviet Union as the Tuva Autonomous Oblast.

The oblast occupies a large valley between the Tannu-Ola Mountains on the south and the Savinsky Range on the north. The latter ridge, lying north of the Sayan Mountains, is a part of the Dzhebash Range. Originating within the confines of the Tuva Valley are the Khua Kem and the Bei Kem, the two streams which unite to form the mighty Yenisei River. At the fork of the rivers is located Kyzyl, the capital. Despite the presence of rich black soils, the natives, of Turkic and Mongolian origin, were nomadic herdsmen, for the region is the southernmost limit of the reindeer belt. Now collectivized and settled, the Tuvinians are producing enough wheat for export, and are exploiting the abundant reserves of coal, iron ore, copper, gold, silver, cobalt, platinum, asbestos, and, reportedly, uranium. Electric power stations are in operation. Although the oblast had no railroad in 1950, it was in touch with Abakan, the capital of the Khakass Autonomous Oblast, by a paved road, and the Yenisei River makes the near-by highly industrialized Kuznetsk-Minusinsk district accessible. Pop. (est. 1954), 175,000.

D. L.

**T.V.A.** *See* TENNESSEE VALLEY AUTHORITY.

**TVER.** *See* KALININ.

**TWAIN, MARK.** *See* CLEMENS, SAMUEL LANGHORNE.

**TWANA.** *See* INDIAN TRIBES, NORTH AMERICAN (*North Pacific Coast*).

**TWEED, WILLIAM MARCY** (1823-1878), American political boss, was born on Apr. 3, 1823, in New York City. He attended schools in New York and in Elizabeth, N. J., and became a bookkeeper. In 1850 Tweed organized a volunteer fire department in New York City and took advantage of the popularity he gained from this venture by running for New York City alderman in 1852. He was elected and served as alderman for four years. During that time he was

elected to the Federal House of Representatives but after one term, 1853-1855, returned to full-time participation in municipal politics. He was defeated for re-election as alderman in 1856 but managed to be elected to a new board of supervisors, set up to check corruption at elections. Under Tweed's machinations the new board soon degenerated into a corruptive body. Tweed managed to get his friends appointed to such important city offices as district attorney, recorder, and county clerk; these appointments were the foundation of the Tweed machine. By 1859 Tweed was the

WILLIAM MARCY TWEED

BROWN BROTHERS

most powerful figure in Tammany Hall and practically dictated the Democratic nominations. He dominated the Democratic State Convention in 1860 and by skillful political maneuvering, accompanied by liberal bribes, all but controlled the state by 1868. Tweed ran the Democratic Party and captured elections from the opposition by coercion, bribery, and illicit votes. He amassed his funds for bribery and his vast personal fortune by raiding the municipal treasury systematically. He organized a law office, though he knew little law, and received huge "retainers" from such favor-seeking clients as Jay Gould's Erie Railroad. He established a printing company and assigned all city printing to that organization; companies dependent on Tweed's friendship for their own survival also patronized the firm. Tweed set up a marble company, began the construction of a new county courthouse, and then sold his own marble to the city at fraudulent prices. He also set lower taxes and sold city bonds at ridiculously low rates, for considerations from the persons or companies involved. Tweed was a member of the New York State Senate from 1867 to 1871 and in 1868 was elected Grand Sachem of Tammany Hall, an honor he sought to accompany the power he had.

Meanwhile certain civic groups and individuals, particularly Samuel J. Tilden, chairman of the Democratic State Committee, Thomas Nast, the cartoonist, and George Jones, owner of the *New York Times,* were attacking Tweed, and when the *Times* obtained and published factual information concerning his thefts of public money, Tweed was arrested for fraud on Dec. 16, 1871. The jury disagreed at his first trial but at his second he was convicted and sentenced in November 1873 to twelve years' imprisonment on Blackwell's Island, New York. He was released in January 1875, little more than a year later, but was immediately rearrested to face an action brought by the State of New York for recovery of the more than six million dollars Tweed had taken from the city. He was confined to the Ludlow Street Jail but escaped in December 1875 and fled to Cuba and then to Spain. He was arrested in Spain and returned to the United States in November 1876 and again confined to Ludlow Street Jail, where he died, Apr. 12, 1878.

W. E. A.

**TWEED,** a river in southern Scotland. The Tweed rises at Hart Fell in the southern uplands of Peebles County, 1,500 ft. above sea level, and flows generally east, through broad fertile valleys and small wooded hills, to empty into the North Sea at Berwick-on-Tweed, running a total distance of 103 mi. Its last miles form the border between Scotland and England. Celebrated in poetry and romance, the "silver Tweed" flows past the famous abbey sites of Melrose, Kelso, and Dryburgh. Its principal tributaries are the Whiteadder, Till, Leader, Ale, Teviot, Gala, and Ettrick rivers. Peebles, Galashiels, Coldstream, and Berwick-on-Tweed are among the principal cities on its banks. S. Van V.

**TWEEDSMUIR PARK.** *See* CANADIAN PROVINCIAL PARKS.

**TWELFTH NIGHT.** *See* HOLIDAYS AND HOLY DAYS.

**TWELFTH NIGHT** (1601-1602), a comedy by Shakespeare. More carefully planned than *As You Like It,* more poetical than *Much Ado About Nothing,* it presents a happy balance of plot, characterization, and diction. Character is not sacrificed to plot, nor does the action become a mere background for the display of characters. The main plot, derived ultimately from an Italian *novella,* deals with the hapless love of Viola, disguised as a page, for her master, Duke Orsino. She bears his messages of love to the Lady Olivia, who at once falls in love with her. When Viola's twin-brother Sebastian appears, Olivia mistakes him for the page and marries him off-hand. The tangled situation is cleared up when brother and sister meet and recognize each other; the Duke rewards Viola's devotion by an offer of marriage, and all ends happily.

This romantic story is set against a background of daily life in Olivia's household, crowded with realistic figures: Olivia's conceited steward, Malvolio; her mischievous waiting-maid, Maria; her hard-drinking cousin, Sir Toby Belch; and her foolish suitor, Sir Andrew Aguecheek. By means of a forged letter Sir Toby and Maria trick Malvolio into believing that his mistress loves him, and his absurd behavior thereafter leads to his temporary confinement as a madman. A singing clown wanders back and forth between the households of Olivia and the Duke; the play begins with music and ends with a song. T. M. P.

**TWELVE TABLES, LAW OF THE.** *See* LAW (*Civil Law*).

**TWELVE TRIBES.** *See* TRIBES OF ISRAEL, TWELVE.

**TWENTY-ONE DEMANDS,** a Japanese attempt to secure hegemony over China in 1915. On January 18, the Japanese minister to China presented President Yüan Shih-k'ai, the Chinese dictator, with twenty-one demands. Arranged in five groups, the demands commanded China to agree to Japan's settlement of German rights in Shantung; to concede Japanese pre-eminence in communications and in economic and political affairs in south Manchuria and eastern

Inner Mongolia; to convert China's biggest mining and smelting concern, the Hanyehp'ing ironworks, into a joint Japanese-Chinese firm; not to cede or lease any bay, harbor or island on the Chinese coast to another power without Japan's consent; and to appoint Japanese military and financial advisers in the Chinese government. Preoccupation of the other great powers with World War I gave Japan her opportunity to seek domination over China. On Aug. 23, 1914, Japan declared war on Germany. Shortly thereafter the Japanese notified China that military necessity required the Japanese occupation of wholly Chinese territories in the vicinity of the German-leased territory of Chiaochou (Kiaochow). In a vain attempt to limit the extent of war on her own territory, China defined a war zone Sept. 3, 1914, within which the belligerents were requested to operate. The Japanese disregarded these limits in attacking the German garrison overland and in occupying the railway line inland to Tsinan. The Germans surrendered November 7, after a skillful defense. Two months later the Chinese government issued a declaration abolishing the war zone and requesting the Japanese to withdraw their forces to the German territories only.

The Japanese then determined to settle outstanding issues between themselves and China by issuing the twenty-one demands. Although the Japanese minister to China prohibited Chinese publication of the demands, the news leaked out.

The Chinese refused full agreement, but negotiated a compromise arrangement which gave Japan extensive economic rights, prolonged Japan's legal tenure in Manchuria, and laid the foundation for future Japanese aggression which preceded World War II. These concessions were embodied in two treaties signed May 25, 1915. D. Ch.

**TWI.** *See* AFRICAN PEOPLES.

**TWILIGHT,** a phenomenon of the atmosphere, referring to the light of the sky before sunrise and after sunset. The morning astronomical twilight is defined as beginning when the sun's center is 18° below the eastern horizon. Nautical twilight begins at 12° below, and civil twilight at 6° below. Similarly, evening twilight ends when the sun's center is respectively at the same positions below the western horizon. When the sun's altitude is —18°, the faintest naked-eye stars are generally visible. During twilight, the air of the atmosphere is illuminated, and is reflecting and scattering the solar light. Total absence of a twilight zone on the moon betrays an absence of atmosphere on that globe. The duration of twilight varies with the latitude of observation and the time of year. The minimum is 1 hr., 8 min. at the equator at equinox times; at latitude 40° it is 1 hr., 30 min. at the equinoxes; and, in high latitudes, twilight lasts all night in the summer, or the "midnight sun" may be in evidence. H. S. R.

**TWINBERRY.** *See* PARTRIDGEBERRY.

**TWIN FALLS,** a city in southern Idaho, the county seat of Twin Falls Co., situated on Rock Creek, a tributary of the Snake River, about 147 mi. southeast of Boise. The farmers in the surrounding irrigated region engage in diversified agriculture. Founded in 1904 and named for the near-by Twin Falls on the Snake River, the community was first incorporated in 1905. In 1951 it had the city-manager form of government. North of the city is the Black Lava Canyon of the Snake River, spanned by a bridge 476 ft. high, and 6 mi. north is the famous Shoshone Falls. Transportation facilities are provided by the Empire and United air lines and the Union Pacific Railroad. The village's economic interests are connected with the agriculture of the region, and the industrial establishments include a sugar-beet factory, starch plant, creamery, and cannery. Pop. 1950, 17,600.

**TWINFLOWER,** a delicate, trailing evergreen plant, *Linnaea borealis,* of the honeysuckle family, growing in moist woods throughout the cooler parts of the North Temperate Zone. The slender stems bear bell-like, pinkish flowers in pairs above small oval leaves. This lovely woodland plant was named for Linnaeus, the great Swedish botanist, at his own request, as it was his favorite flower. The American form, *L. b. americana,* is found from Labrador to Alaska, and in the mountains south to Maryland and California. G. M. Sm.

THOMÉ—DR. LASCOFF

*TWINFLOWER,* LINNAEA BOREALIS

**TWINS.** *See* EUGENICS.

**TWO GENTLEMEN OF VERONA, THE** (c. 1593), one of Shakespeare's early comedies. The playwright drew his material for this play from Montemayor's *Diana Enamorada,* a popular Spanish romance which he may have read in a French translation. He tried to convert a rambling narrative into a romantic comedy, but with little success. Shakespeare's mastery of his art was as yet incomplete, for in plot construction this is one of the weakest of his plays. The two gentlemen are the friends, Proteus and Valentine. Proteus is in love with Julia, but deserts her—and betrays Valentine—to win the hand of Sylvia, whom Valentine loves. In the last scene the friends are reconciled, Valentine wins Sylvia, and Proteus is reunited with Julia, who has followed him disguised as a page.

The action of the play is slow in starting; the denouement is hurried and forced. On the other hand, Shakespeare succeeded in making character account for plot; there would be no action at all if Proteus had not been fickle and Julia faithful. The two servants, especially Launce with his dog, add a dash of realistic comedy to a romantic play, but the peculiar charm of *The Two Gentlemen* is the lyric grace of its poetry. T. M. P.

**TWO KETTLE.** *See* Indian Tribes, North American (*Plains*).

**TWO RIVERS,** a lake port and city in eastern Wisconsin, in Manitowoc Co., on Lake Michigan, about 90 mi. north of Milwaukee, at the mouth of the East Twin and the West Twin rivers. Founded in 1836 and named for its location at the junction of the rivers, the community was incorporated as a city in 1878. In 1951 it had the council-manager type of government. The Chicago and North Western Railway furnishes transportation, and the city's harbor is used by a commercial fishing fleet and barges delivering coal. Timber is a natural resource of the region, and local industries produce aluminum, plywood, electrical products, woolens, and metalware. The surrounding forest and lake country, together with the city's bathing and fishing facilities, attracts many vacationists. Pop. 1950, 10,243.

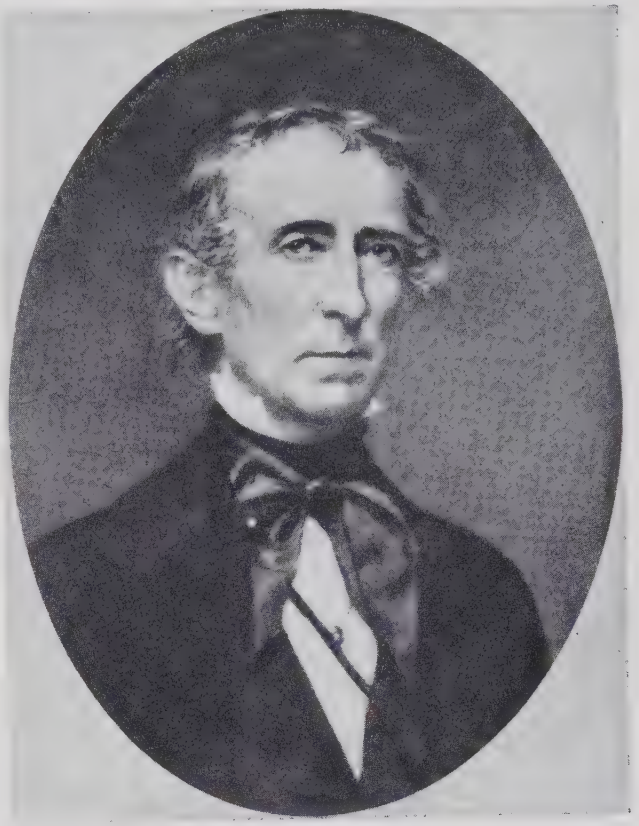
**TWO SICILIES, KINGDOM OF THE.** *See* Sicily (*History*).

**TYLER, JOHN** (1790-1862), tenth President of the United States, was born at Greenway, Charles City County, Va., on Mar. 29, 1790. His father, Judge John Tyler, Governor of Virginia 1808-1811, and his mother, Mary Armistead Tyler, were both of English descent. He was educated at a neighborhood school and at William and Mary College, from which he graduated in 1807. He read law under his father and was admitted to the bar in 1809.

**Public Life.** During the War of 1812, Tyler served for a short time in a local militia unit which did not see active service. In 1811 he was elected to the Virginia legislature, serving until 1816, when he was sent to the House of Representatives from his home district. As a member of the House from 1816 to 1821, Tyler, unmoved by the wave of nationalism in the country, supported the states' rights and strict constitutional interpretation of the early Jeffersonians. In doing so he opposed the majority of his party by voting against the rechartering of the Bank of the United States, the tariff acts, and internal improvement measures. A pro-slavery man, he was convinced that the national government had no constitutional right to restrict slavery in any territory, and consequently voted against the Missouri Compromise Act. During the remainder of his life Tyler refused to vary the strict constitutional and slavery views he held in his youth.

Because of failing health he left Congress in 1821 and returned to Virginia, where he lived quietly as a private citizen for two years. In 1823 he was again elected to the state legislature and became governor of Virginia in 1825. Two years later he was elected to the United States Senate in the place of John Randolph of Roanoke. In 1824 Tyler supported W. H. Crawford for president and opposed Andrew Jackson, whom he considered merely an able frontier fighter and not a statesman. In 1828, however, he was more opposed to John Quincy Adams than to Jackson and actually supported the new President during the first part of his administration. Tyler was equally opposed to South Carolina's nullification of the national tariff act and Jackson's Force Bill, and he was the only Senator to cast a vote against the latter measure. Breaking with the Jackson Democrats after the Force Bill had passed, he became a member of a Southern Rights faction, which acted with the National Republicans, later Whigs, but which had little in common with Whig principles. Tyler remained in the Senate until 1836, supporting Jackson on the Bank issue, but bitterly opposing the President's withdrawal of funds from the Bank. He resigned his seat in 1836 rather than follow the instructions of the Virginia legislature to support the resolution expunging from the Senate minutes a previous censoring of President Jackson.

**The Presidency.** Tyler was nominated in 1836 for the vice-presidency by a group of states' rights Whigs and received 47 electoral votes in the following election. Four years later, in the belief that he would help carry the South, he was selected by the Whigs as their vice-presidential candidate on a ticket headed by William H. Harrison. Elected by a large vote, he automatically became the chief executive in April 1841 when Harrison died. Immediately Tyler's strict states' rights views conflicted with the nationalistic ideas of Henry Clay, the nominal Whig leader in Congress. Since Tyler was the first vice-president to be automatically elevated to the presidency, Clay tried to curtail his powers by suggesting that as only an "acting president" he did not have the full constitutional rights of an elected chief executive. Tyler, however, insisted upon retaining the full powers of his office and was later responsible for defeating the enactment of Clay's American System. After Tyler had twice vetoed the bill rechartering a national bank, Clay declared him a party outlaw and persuaded all the Whigs except Daniel Webster to retire from his Cabinet. Webster remained until 1842 to negotiate the famous Webster-Ashburton treaty. Tyler was now a man without a party and without significant support in either house of Congress.



FABIAN BACHRACH

*JOHN TYLER, TENTH PRESIDENT OF THE UNITED STATES*

During the last two years of his administration his one great desire was to accomplish the annexation of Texas. His Secretary of State, A. P. Upshur, had all but completed a treaty with Texas when he was killed by an explosion on

the United States gunboat *Princeton*. Tyler then appointed John C. Calhoun as Secretary of State, but the latter's treaty was defeated in the Senate. Texas was finally annexed by a joint resolution passed by both houses of Congress after the election of 1844, but before Tyler had left office.

**Later Life.** Tyler had many supporters in both parties scattered throughout the country and in 1844 was actually nominated by a Democratic states' rights convention. He withdrew his name from consideration, however, when James K. Polk was nominated by the regular wing of the Democratic Party. Leaving office in March 1845, he retired to Virginia with his new wife, the former Julia Gardiner, whom he had married after his first wife, Letitia Christian Tyler, had died in 1842. From 1845 until 1860 Tyler practiced law, looked after his estate, and occasionally took an interest in local politics. When the dispute over slavery threatened war in 1860-1861, he led the movement that resulted in the calling of a border state convention to work out a compromise plan to save the Union. After acting as chairman of that fruitless meeting held in Washington, D. C., and when all hope of a compromise was gone, he supported secession in the Virginia convention. He was subsequently elected to the Confederate House of Representatives but died in Richmond, Va., on Jan. 18, 1862, before he could take his seat. G. E. M.

**TYLER,** a city in northeastern Texas, the county seat of Smith Co., about 100 mi. southeast of Dallas. The community, named in honor of President John C. Tyler, was first incorporated in 1846. In 1951 it had the city council-manager form of government. It is the seat of Butler and Texas colleges for Negroes, Tyler Junior College, and Tyler Commercial College. Transportation facilities are provided by the Missouri Pacific and the St. Louis Southwestern railroads and by the Delta and Mid-Continent air lines. Tyler is the shipping center for a fertile agricultural region in which tomatoes, cotton, sugar cane, grain, and nuts are grown. It is an important transfer point for the area's oil, gas, lignite, and iron ore. In addition, Tyler is reputed to be the rose-bush center of the United States, shipping millions of bushes throughout the country each year, and it is the site of the annual Texas Rose Festival. Its location as the largest city between Dallas to the east and Shreveport, La., to the west is primarily responsible for the city's development as the retail and wholesale trade market for the surrounding territory. The diversified local manufactures include clothing, water heaters, battery cases, optical instruments, foundry products, brick and tile, plastics, crates and baskets, and airplanes. Food canning, processing, and dehydrating are also carried on in Tyler. Pop. 1950, 38,968.

**TYLOR, SIR EDWARD BURNETT** (1832-1917), British anthropologist, was born in Camberwell on Oct. 2, 1832. He was educated at Grove House School, Tottenham, but received no university training. After a brief business career, he was obligated by ill health to travel, and in 1856 he went to Mexico with Henry Christy, pioneer archaeologist and prehistorian. This visit was largely responsible for turning Tylor to anthropology, and led to the publication of his first book, *Anahuac: or Mexico and the Mexicans* (1861). His second book, *Researches into the Early History of Mankind and the development of Civilization* (1865), laid the foundation of Tylor's professional fame, which reached its peak with the appearance of *Primitive Culture* (1871) and *Anthropology: an Introduction to the Study of Man and Civilization* (1881).

Unlike his contemporaries, most of whom were preoccupied with special problems, Tylor's ethnological interests were universal, and his anthropology concerned itself with the unity of human culture envisaged as a continuity. In spite of the meager data then available, his critical judgment was cautious and sound. Although he adhered to the unilinear scheme of cultural evolution then generally accepted, he was at the same time aware of the importance of diffusion as a dynamic of culture growth. His theory of animism as presented in *Primitive Culture* is one of the most impressive theories of primitive religion yet advanced. The first to apply statistical methods to ethnological data, he also contributed the useful concepts of survivals and adhesions.

From 1884 to 1909 Tylor was associated with Oxford University, first as reader in anthropology, and later as Oxford's first professor of anthropology. In recognition of his outstanding contributions to learning, he was knighted in 1912. Tylor died at Wellington on Jan. 2, 1917. H. T.

**TYMPANUM.** *See* Architectural Terms.

**TYNDALE, WILLIAM** [tɪ′ndəl] (c.1490-1536), English Reformer and translator of the New Testament and the Pentateuch, was born near the border of Wales between 1490 and 1495. At Oxford, where he received an M.A. in

*WILLIAM TYNDALE*

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1515, and at Cambridge he became interested in reading the Greek New Testament, and, after tutoring for a year and being ordained, he resolved to translate the New Testament into English to remedy the ignorance of the clergy. Failing to enlist the help of the Bishop of London, Tyndale left England in 1525 and went to Wittenberg, where he met Luther. Driven from Cologne when his translation was partly printed, he fled to Worms, where he published his first edition, without his name, in 1525. It was widely distributed in England before the authorities discovered and burned it as dangerous.

As a hunted man, Tyndale moved frequently. He engaged in a pamphleteering controversy with Chancellor Sir Thomas More from which he emerged as the English champion of the Reformation. In 1534 he printed a revised edition of his New Testament, employing a dignified style which later formed the basis for the authorized version of the Bible in 1611. Betrayed by a false friend, he was thrust into prison at Vilvorde, near Brussels, where he translated at least the first five books of the Old Testament. Tyndale was tried at Vilvorde, condemned, and, on Oct. 6, 1536, burned at the stake. C. A. A.

**TYNDALL, JOHN** [tɪ′ndəl] (1820-1893), British natural philosopher, was born at Leighlinbridge, County Carlow, Ireland, on Aug. 2, 1820. Educated in the local schools, in 1840 he began work in the Irish ordnance survey office, being transferred to the English survey in 1842. From 1844 to 1847 he was a railway survey engineer, but in August 1847 he joined the teaching staff of Queenwood College, near Stockbridge, Hampshire, said to be the first school in England to adopt practical and laboratory work in the teaching of applied science. The following year he went to the University of Marburg, Germany, where two years later he received his doctorate. He returned to Queenwood in 1851, was elected a fellow in the Royal Society on June 3, 1852, and on July 6, 1853, became professor of natural philosophy at the Royal Institution. Tyndall had begun to establish his reputation as a scientist and as an investigator, though much of his fame is due to his personality and skill as a lecturer rather than to the originality of his research. His investigations into the characteristics and properties of radiant heat (1859-1871) probably constitute his major scientific contribution. He was also in demand as a scientific adviser. In March 1887 Tyndall resigned his chair at the Royal Institution because of his continued poor health and retired to his country home, Hindhead House, Surrey, where he died on Dec. 3, 1893.

Of his many books and scientific papers, *Heat Considered as a Mode of Motion* (1863) was probably his most authoritative publication. Other important books were *On Sound* (1867) and *Contributions to Molecular Physics in the Domain of Radiant Heat* (1872). T. R. H.

**TYNDAREUS** [tɪndɛ′əriəs], in Greek legend, the son of Perieres and Gorphone, or of Oebalus of Sparta and the nymph Batia. He and his brother Icarius were driven from Sparta by another brother, Hippocoön. Tyndareus fled to Aetolia, where he married Leda, the daughter of Thestius, but he was later restored to Sparta by Heracles, who slew Hippocoön and his sons. By Leda, Tyndareus became the father of Clytemnestra and Castor, while Helen and Pollux were the children of Zeus and Leda; according to another tradition, Zeus was also the father of Castor. The patronymic Tyndaridae, or "sons of Tyndareus," was sometimes given to Castor and Pollux. *See also* LEDA. G. E. D.

**TYNE** [tai′n], a river formed by the union of the North Tyne and South Tyne in Northumberland, England. The former rises in the Cheviot Hills, the latter just below Cross Fell; united in the Tyne, they flow into the North Sea. The Tyne has been dredged to take larger and larger ocean-going vessels; its high spring tides reach a height of 29 ft. as far up as the bridge town of Newcastle. The Tyne is the chief harbor area of the northeast coast, and from Newcastle to Gateshead its banks are lined with shipyards, glass and chemical works, and lead-smelting and iron furnaces. Its length is about 80 mi. and it drains an area of 130 sq. mi. S. Van V.

**TYNEMOUTH** [tai′nməth; tɪ′nməth], a municipal, county, and parliamentary borough and coast guard station in Northumberland, England, situated at the mouth of the Tyne River, about 270 mi. northwest of London. Tynemouth was a Roman settlement, but its history actually begins with a seventh-century monastery which was raided at least three times and totally destroyed. Another monastery was erected in the eleventh century, of which remains stand. Charters were granted to the prior in 1203 and 1204, but Tynemouth did not become important until the nineteenth century, for up until that time the citizens of Newcastle, 8 mi. to the east, would not permit the establishment of a port. The town, incorporated in 1849, was made a county borough in 1904. During World War II Tynemouth, with other towns on the Tyne River, was bombed, particularly from July 1940 through December 1941. The community is a popular resort. Its principal industry is fishing. Pop. 1952, 66,900. A. W.

**TYPE.** *See* PRINTING AND GRAPHIC ARTS.

**TYPEWRITER.** *See* BUSINESS MACHINES AND EQUIPMENT.

**TYPHOID FEVER,** enteric fever, an acute, specific human infectious disease, caused by a bacterium, *Eberthella typhosa.*

**History.** Thomas Willis, in 1643, first described typhoid fever. It was often confused with typhus fever until Gerhardt in 1837 distinguished the two, and coined the name, which means typhuslike. Budd in 1856 epidemiologically proved its infectiousness via the patient's feces. Eberth in 1880 demonstrated the typhoid bacillus. Severe typhoid mortality in the Spanish-American and Boer wars led to the development of the protective typhoid vaccine (Kolle, Pfeiffer, Wright, Russell). The sharp reduction of typhoid fever incidence in all countries employing sanitary procedures since the turn of the century is one of the outstandingly successful contributions of public health methods.

**Epidemiology.** The most important modern source of the typhoid bacillus, which is of world-wide distribution, is the typhoid carrier. These carriers at times unwittingly contaminate water, milk, or food, and initiate typhoid epidemics. Raw shellfish, fresh fruits and vegetables, and flies may be vehicles of infection. The large-scale, summer, water-borne typhoid outbreak, so common 40 years ago, emanating from a single case, is becoming a rarity in areas where sanitary measures are enforced.

**Pathology.** The typhoid bacillus enters the body by being swallowed. It lodges in the Peyer's patches of the lower small intestine, where it multiplies, and invades the blood stream, when fever begins, about ten days after infection. Lymphoid tissue all over the body, including the spleen, exhibits a characteristic inflammatory change.

**Clinical Course and Diagnosis.** Typhoid begins insidiously with malaise, headache, body pains, and loss of appetite during the first week, while the fever builds up gradually to 104°. It stays at this level, or plateau, for a week or two, with a daily fluctuation of a degree or so, then over another two weeks recedes to normal. In most cases there appears after the first week an abdominal rash, the rose spots. The pulse is slow, relative to the fever, and the white blood count is low. The abdomen becomes bloated with gas very early and remains so; constipation is the rule, alternating with the passage of the typhoidal "pea soup stool." Nosebleed and bronchitis are frequent symptoms. At the height of the fever the patient appears extremely ill; he is stuporous and mildly delirious by turns. Absolute diagnostic proof is furnished by finding the typhoid bacillus in the blood the first week, and in the feces and urine the second. The Widal test, clumping of typhoid bacilli by the patient's blood serum, becomes positive in the second week but is not so reliable diagnostically as a positive culture. Complications of typhoid are intestinal hemorrhage and perforation, pneumonia, thrombosis, and laryngitis. Relapses are frequent but, as a rule, mild.

**Treatment.** With good treatment and nursing, mortality is about 10 per cent. Various antiserums and a specific

bacteriophage show promise. Streptomycin has proved of little value. The old fluid diet has been replaced by full feeding. Sponge baths or cold packs help reduce temperature. Intestinal perforation calls for immediate surgical closure. F. P. Ma.

**TYPHOON.** *See* METEOROLOGY.

**TYPHUS FEVER,** an acute, severe, louse- and flea-borne infectious disease, caused by *Rickettsia prowazeki.* There are two very distinct types: the epidemic and the endemic.

**Epidemic Form.** Epidemic typhus fever, also called classical typhus, ship fever, jail fever, or *tabardillo,* is primarily a disease of the Old World. It first appears definitely in history in Germany in the sixteenth century. Since then typhus has repeatedly been a decisive factor in military history; its ravages often exceeded battle casualties, as in the Thirty Years' War, Napoleon's Russian invasion, the Crimean War, and World War I. Three million typhus deaths occurred in the Soviet Union between 1917 and 1921.

Since this type of typhus is commonest in winter and since lice flourish in thick winter clothing, and in wartime crowding and dirt, suspicion early turned to the louse as a vector; in 1909 Charles Nicolle proved the transmission of typhus fever from man to man by the body louse, *Pediculus humanus corporis.* The head louse is also a vector of typhus, but not the crab louse. There is no animal reservoir of epidemic typhus. Between epidemics the disease lies dormant in human cases which have become chronic, or carriers. Such cases, described as Brill's disease, are occasionally seen in the eastern United States. In epidemics, the louse catches the disease from biting an infected human. A few days later, its intestinal tract is filled with the typhus *Rickettsia,* and the louse becomes infective and dies after about 12 days. The direct bite of the louse does not introduce the disease; it is caused by the scratching into the bite of the louse feces deposited near by. The typhus-producing *Rickettsia* is smaller than most bacteria, and needs living tissue for its growth. It invades and destroys the lining of the smaller blood vessels. The incubation period in man is 10 to 14 days. The onset is abrupt, with chills, fever, headache, backache, and a few days later a spotty rash, first seen on the abdomen. Fever rises fairly smoothly to about 104° but drops rapidly after 2 weeks. More than half the patients may die in a severe epidemic. The disease may be diagnosed positively the second week by the complement fixation and Felix-Weil blood tests. Prevention lies in immunization by vaccine and in louse control. World War II gave large-scale proof of the efficiency of Cox's vaccine, grown in chick embryos. The widespread use of DDT powder is apparently more efficient than the older, steam delousing methods.

Para-amino-benzoic acid is the only drug showing much promise in treatment. Good nursing is very important.

**Endemic Form.** Endemic typhus fever, murine, American, or flea typhus, accounts for about 5,000 cases in the United States annually. This type occurs in the warmer parts of both hemispheres. It is largely a rural and a summer disease, and is much milder than epidemic typhus. It is primarily a disease of rats, which is transmitted to man by the rat flea; rat control is therefore of utmost importance in its prevention. F. P. Ma.

**TYPOGRAPHICAL UNION, INTERNATIONAL.** *See* INTERNATIONAL TYPOGRAPHICAL UNION.

**TYPOGRAPHY.** *See* PRINTING AND GRAPHIC ARTS.

**TYRANNICIDES.** *See* HARMODIUS AND ARISTOGITON.

**TYRE** [tai'r] (Arab. Es Sur), important commercial city of antiquity, south of Beirut on the coast of Lebanon at the east end of the Mediterranean Sea. At the time of his visit to Tyre, about 450 B.C., Herodotus was told by the priests of Melkarth that their city had been founded 2,300 years before, or about 2750 B.C. The earliest reference to Tyre in contemporary historical sources is in the Tell el-Amarna tablets of the fourteenth century B.C. These include ten letters addressed to the Pharaoh by Abi-Milki, governor of Tyre, indicating that the city was then subject to Egypt. Part of the city was on the mainland, while the seaport was on two rocky islands off the coast. The island location gave the city its Semitic name Es Sur, "the rock," and this name became Tyre in Greek. Since it was the most important of the Phoenician cities, the Greeks also gave its name to the whole region, which they called Syria.

The best-known king of Tyre was Hiram, the contemporary of the Hebrew kings David and Solomon. As narrated in the Bible, Hiram provided craftsmen and materials for the building of David's palace and of Solomon's temple and palace, and also sent "shipmen that had knowledge of the sea" to sail in Solomon's navy. At Tyre, Hiram connected the smaller, more westerly island, on which the famous temple of Melkarth had long stood, with the larger island by means of an embankment; he also enriched the temple of Melkarth with donations of gold and with the dedication of a pillar of gold. The seventh king after Hiram was Ethbaal, whose daughter Jezebel married King Ahab and promoted the worship of Baal in Israel.

In the Assyrian, Neo-Babylonian, and Persian periods Tyre was for the most part subject to these great powers of the East. Assyrian kings from Ashurnasirpal II to Ashurbanipal record the subjecting of Tyre and the taking of tribute from its inhabitants. Nebuchadnezzar II of Babylon kept the city under siege for thirteen years while Ethbaal II was king, and the Persians included Tyre in the fifth satrapy of their far-flung empire.

Alexander the Great took the city in 332 B.C., but only after a terrific seven months' struggle in which he built a mole from the mainland to the island, and attacked by ship from the sea as well. Alexander's embankment was widened by natural deposits of sand, and now provides an arm of land more than a quarter of a mile wide reaching from the mainland to the former islands. Later Tyre passed under Egyptian control; then in 198 B.C. it was taken by the Seleucids, from whom it gained self-government in 126 B.C. Rome took the city in 68 B.C., and under Roman rule it became capital of the province of Phoenicia and its richest commercial city, known for the manufacture of purple dyes from the shell of the murex.

Jesus Christ visited the "borders" of Tyre (Mark 7:24), and Christianity was established there at the time of Paul's visit recorded in Acts 21:3-6. A splendid cathedral was dedicated at Tyre about A.D. 316 by Eusebius of Caesarea, and important church councils were held there in 335, 449, and 514 or 515. The city was held by Arabs from 638 until its capture by the Crusaders in 1124. The chief city of the Latin kingdom of Jerusalem, Tyre was recaptured by Moslems in 1291 and destroyed. With the exception of a brief appearance of the French in 1799, between Napoleon's two Egyptian campaigns, Tyre was under Turkish rule from 1516 until 1918, when the area was taken by British troops under General Allenby. In 1920, it was included in the French Mandate of Syria, which was relinquished during World War II, and in 1941 it was made part of the Republic of Lebanon.

The climate is Mediterranean, with short, cool, wet winters and long, hot, dry summers. The average annual temperature is about 70° F., with a winter average of 56° F. There is, on the average, a rainfall of 30 in. between November and February. Agriculture is the most important occupation, and cereals, vegetables, citrus fruits, and olives are grown. Pop. (off. est. 1948), 9,455. J. F.

**TYROL.** *See* TIROL.

**TYRONE, 2ND EARL OF.** *See* O'NEILL, HUGH.

**TYRONE** [tɪro′n], an inland parliamentary county of Northern Ireland, bounded on the north by County Londonderry, on the east by Lough Neagh, on the southeast by County Armagh, on the south by Monaghan, on the southwest by Fermanagh, and on the west by Donegal. Its extreme length is 55 mi., west to east, and extreme breadth, 37½ mi., south to northeast. With an area of 1,261 sq. mi., it is the largest county of Northern Ireland. In general, the surface is hilly and irregular, rising in the north central part to the Sperrin Mountains, a high, bare, east-west ridge of mica-schist, whose greatest elevation, Sawel Mountain (2,240 ft.), is in County Londonderry. The annual temperature averages from 44° F. to 50° F., the temperature for January being 41° F. and that for July, 60° F. The January rainfall ranges from 3 to 6 in., July rainfall from 3 to 4 in., and the mean annual rainfall from 30 to 60 in.

The principal occupation is agriculture, there being more tilled land in Tyrone than in most Irish counties. On the other hand, Tyrone has less acreage under pasturage than the neighboring counties. A wide area is devoted to oats, potatoes, and flax. Principal manufactures are linens, woolens, and coarse earthenware. Lignite is found along the shore of Lough Neagh. The richest coal deposits in the county are in the small coal field near Coal Island. Marble and red sandstone are quarried in the south near the Monaghan border. Omagh, on the Strule in west central County Tyrone, is the county town. Other large towns are Strabane, Dungannon, and Cookstown.

The county name is a shortened form of the Gaelic *Tir Eoghan,* the territory of Owen-Owen the son of Niall of the Nine Hostages. The whole present county, with Londonderry and part of Donegal, constituted the principality of the O'Neills. There are early Irish stone crosses at Arboe, Coagh, Cookstown, Donaghmore, and Dungannon, and an early Irish church and cross at Errigal Keeroge near Ballygawley. Tyrone attained its maximum population, 312,956, in 1841. Since that year there has been a steady decline in population. Tyrone returns five members to the Parliament of Northern Ireland. With Fermanagh, Tyrone returns two members to the Parliament of the United Kingdom. Pop. 1953, 133,000. S. Van. V.

**TYRONE** [tai′ron], a borough in Blair Co., in central Pennsylvania, situated at the confluence of the Little Juniata River and Bald Eagle Creek, in the foothills of the Allegheny Mountains, 14 mi. northeast of Altoona. Settled in 1850 and incorporated in 1857, Tyrone is governed by a mayor and council. The Pennsylvania Railroad provides transportation facilities for the community's industries, whose products include paper, chemicals, shirts, boilers, mine machinery, and lime and clay products. There are limestone quarries in the vicinity, and agricultural products of the area include apples, grain, and potatoes. Pop. 1950, 8,214.

**TYROSINE.** *See* PROTEINS.

**TYRRHENIAN SEA** [tɪri′niən], that part of the Mediterranean Sea which washes most of the western coast of Italy. It is bordered by the Ligurian Sea on the north, the islands of Corsica and Sardinia on the west, the open Mediterranean and the island of Sicily on the south, and the Italian mainland on the east. It is extremely deep, reaching over 12,000 ft. in some places, and its waters are strikingly clear. The most important islands touched by the sea, other than Sicily, Sardinia, and Corsica, are Elba, Giglio, Montecristo, Ponza, Ischia, Capri, Lipari, and Stromboli. R. W. Cr.

**TYRTAEUS** [tɜrti′əs] (seventh century B.C.), Greek elegiac poet, wrote to encourage the despondent Spartans during the Second Messenian War, perhaps in 635 B.C. Tradition asserts that he was a lame schoolmaster whom Athens, in mockery, sent to help Sparta. Though perhaps of Ionian origin like other early Spartan poets, he sometimes speaks in tones of such authority as to suggest noble Spartan birth. His elegies are martial and political: in some he exhorts the Spartans to vigorous action, contrasting the disgrace of the coward and fugitive with the lasting renown of the patriotic warrior. Other fragments, commending *Eunomia* (orderly government), depict the Spartan constitution, ascribing it to the express ordinance of Apollo. In both respects he clearly reveals the Spartan concept of civic virtue. Like other early elegists, Tyrtaeus uses an epic Ionic vocabulary, though he is closer to Hesiod and the Homeric Hymns than to the Homeric poems; nevertheless, occasional Doric elements are to be found. C. M. D.

**TYUMEN** [tyumye′ny], the name of a region and its chief city in the Russian Soviet Federated Socialist Republic, in the central Soviet Union.

**The City.** Tyumen is a commercial center, about 185 mi. east of Sverdlovsk, at 57° 15′ N. lat., 65° 18′ E. long. It lies on both banks of the Tura River in the great Siberian lowland. An old Tatar settlement, the origin of which is unknown but which appeared on a map of 1546, it was an important center for the movement of exiles and immigrants eastward into Siberia. Though not on the Trans-Siberian Railway, it lies on the important Sverdlovsk-Omsk line. Its waterway traffic is especially important since it receives goods by river boat from Tobolsk, Omsk, Semipalatinsk, and Novosibirsk for shipment to the Urals area. It has large tanneries and small iron works. Manufactured products include silk, wool, river boats, flour, lumber, rope, and machines. Pop. (est. 1950), 110,000. C. C. H.

**The Region.** Tyumenskaya Oblast is an administrative unit of the R.S.F.S.R., located in western Siberia and created in 1945 from part of the old Omsk Region. It is bounded by the Kara Sea on the north, Krasnoyarsk Krai on the east, Tomsk and Omsk oblasts on the southeast, North Kazakhstan on the south, Kurgan and Sverdlovsk oblasts on the southwest, and Komi A.S.S.R. and Nenets National Okrug on the west. It includes Khanty-Mansiyisk and Yamal-Nenets national okrugs. With tundra and the vast water system of the Ob River in the north, most of the region is taiga, or coniferous forest, with a small forest-steppe area in the south. Khanty-Mansiyisk and Yamal-Nenets are sparsely populated, and hunting and fishing are most important in their local economy. In the rest of the region, cereals, livestock, dairy and agricultural products, and timber are produced. The region lacks mineral resources. Pop. (est. 1954), 950,000. W. S. V.

**TZ'Ŭ HSI** [tsʊ′ shi′] (1835-1908), Chinese empress dowager. She entered the palace as concubine of the Emperor

Hsien Fêng in 1852. Presenting the Emperor with his only son, she was elevated to the rank of concubine of the first class, ranking just under the Empress. Upon the death of Hsien Fêng in 1860, Tz'ŭ Hsi, as empress mother, entered upon her first period of power as co-regent. Upon the death of her son, the Emperor T'ung Chih, in 1875, she was instrumental in putting another minor on the throne so as to resume direct rule as regent. Her dominance continued even after this emperor, Kuang Hsü, officially assumed sole power in 1889, in spite of his attempt to assert himself as a reform leader. Failure of the reform movement led to Kuang Hsü's imprisonment from 1898 until his death in 1908. Tz'ŭ Hsi then put another minor, Hsüan T'ung, on the throne so that her regency might continue. Her death in 1908 lessened the ability of the dynasty to survive the revolution in 1911.

The period of Tz'ŭ Hsi's rule was one of increasing strain from foreign pressures and also from internal disintegration. The personal element in Chinese government, which increased under her rule, had a weakening effect on the entire administrative system. It resulted in greater favoritism in the making of appointments, an extensive traffic in office, and irresponsibility due to the influencing of decisions by those who enjoyed her personal favor. Consequently Tz'ŭ Hsi cannot be absolved from a personal responsibility for the condition of China at the time of her death. H. M. V.

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